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Sollami

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(54) TOOL BODY AND METHOD OF MANUFACTURE

(75) Inventor: **Phillip A. Sollami**, Herrin, IL (US)

(73) Assignee: **The Sollami Company**, Herrin, IL (US)

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Related U.S. Application Data

(63) Continuation-in-part of application No. 09/532,994, filed on Mar. 22, 2000, now Pat. No. 6,397,652.

(51) **Int. Cl.**^{7} **B02C 13/28**

(52) **U.S. Cl.** **241/294**; 241/300; 299/105; 299/107

(58) **Field of Search** 241/294, 300; 175/410, 411; 299/105, 107, 104, 106

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Primary Examiner—Mark Rosenbaum
(74) *Attorney, Agent, or Firm*—Robert L. Marsh

(57) **ABSTRACT**

A tool body is cold formed by inserting a blank into a die which defines a portion of the outer surface of the tool body after which a punch applies an impact to the blank causing the outer surface of the blank to conform to the contour of the die. The completed tool has an elongate hub with a cylindrical forward portion having a diameter sized to rotatably fit within the bore of a tool holder and a rearward portion with a diameter a little less than the that of the forward portion. The smaller diameter rearward portion facilitates the insertion and alignment of the tool in the tool holder.

12 Claims, 9 Drawing Sheets

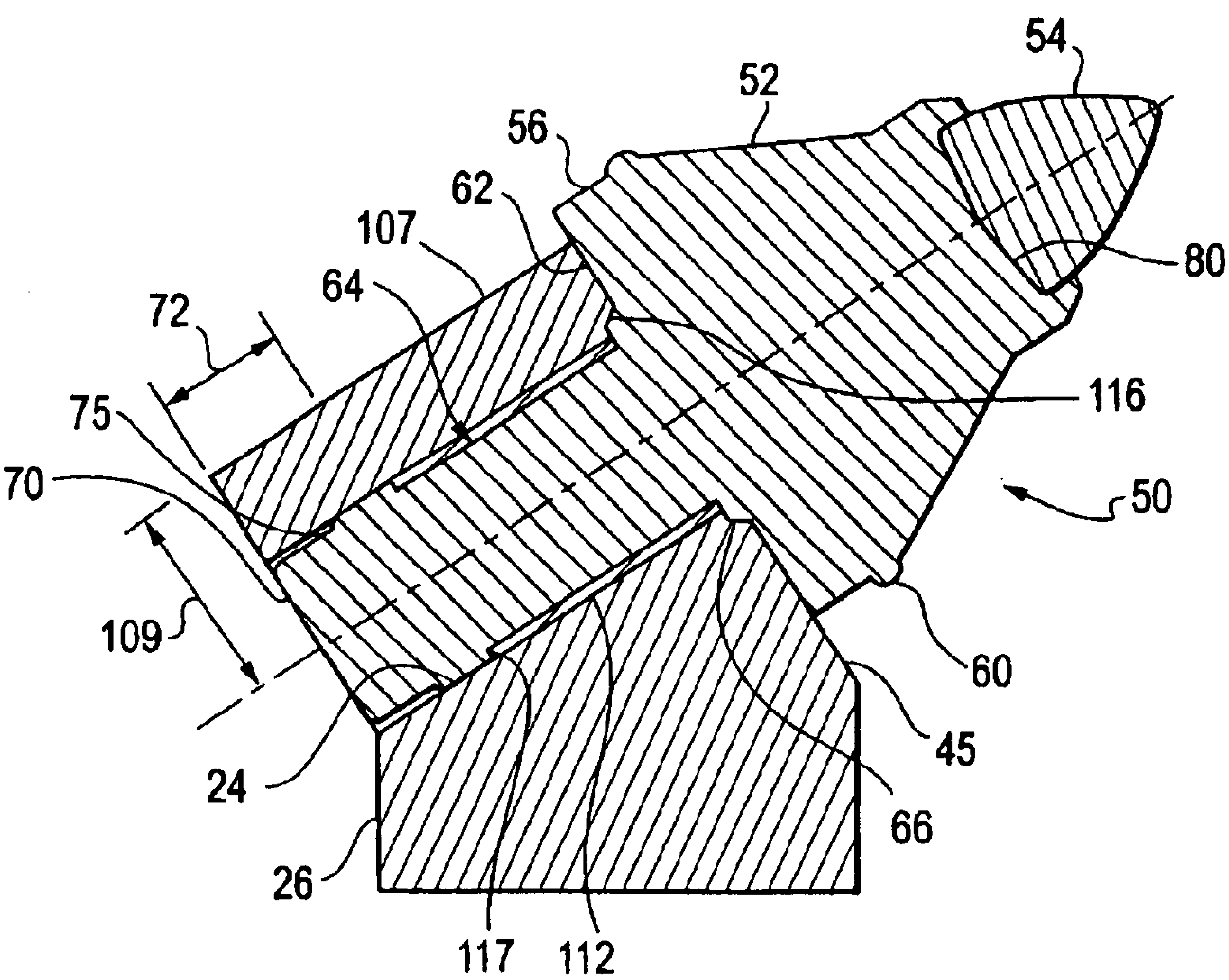

Fig. 1
PRIOR ART

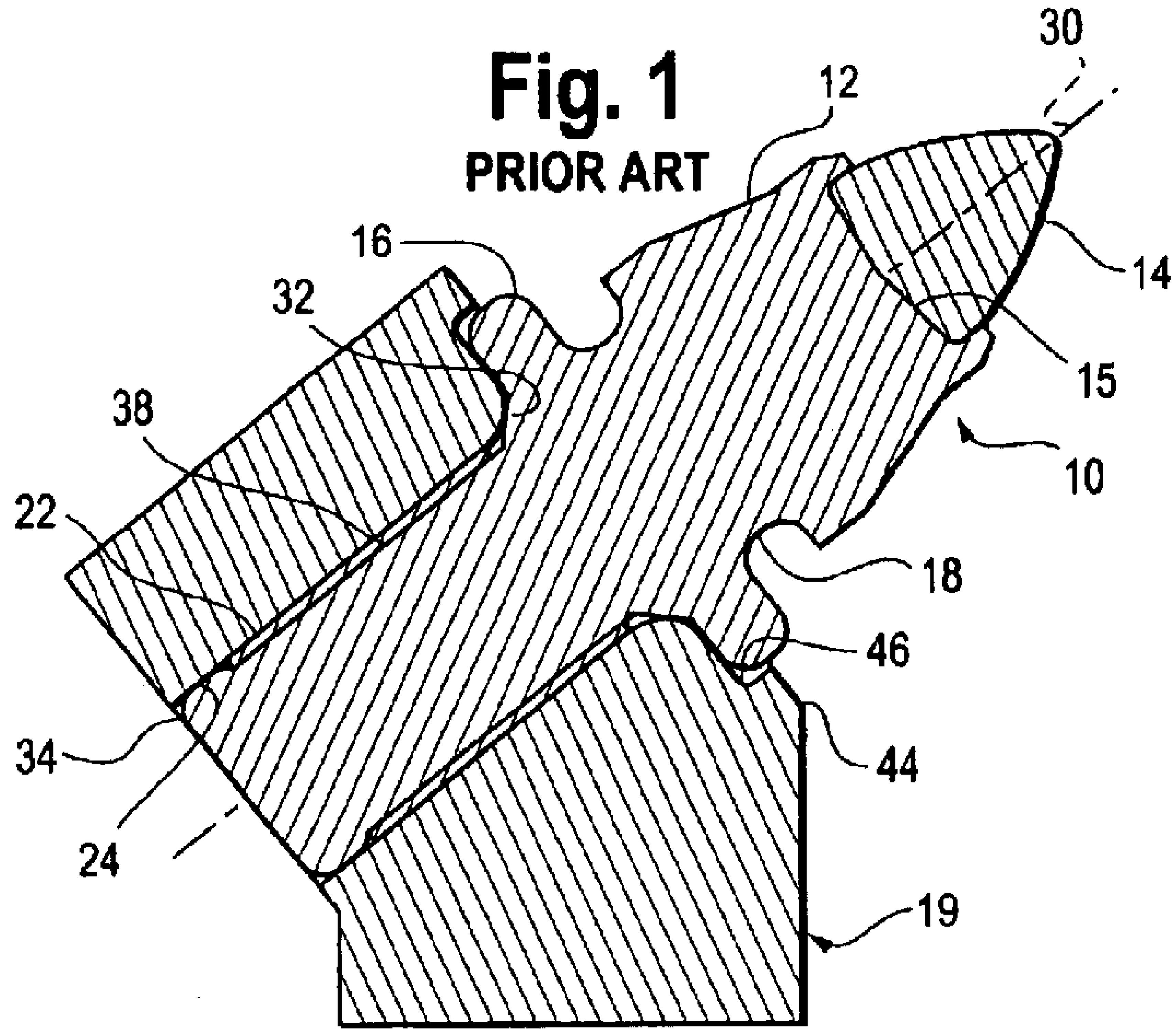

Fig. 1A
PRIOR ART

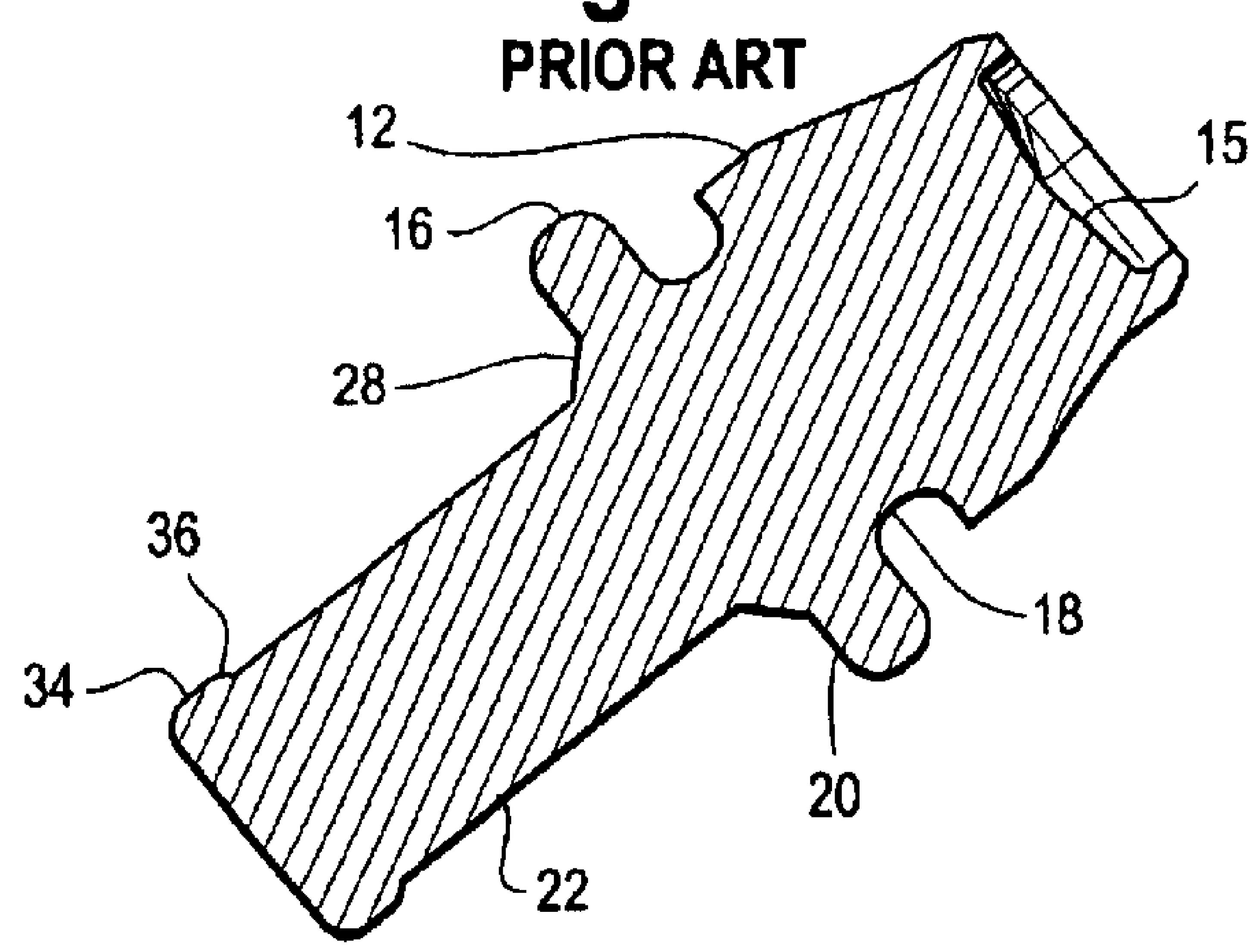

Fig. 2
PRIOR ART

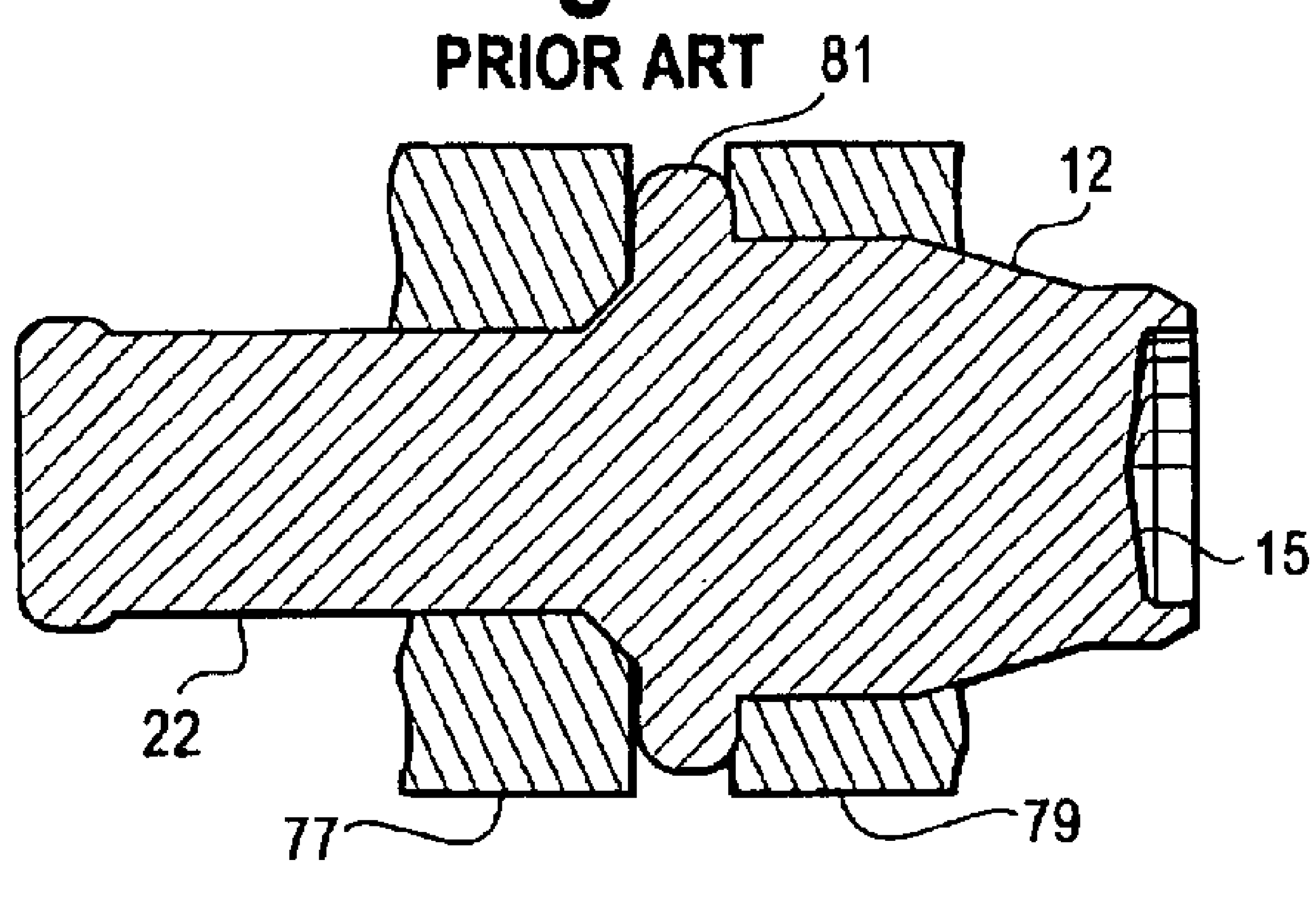

Fig. 3
PRIOR ART

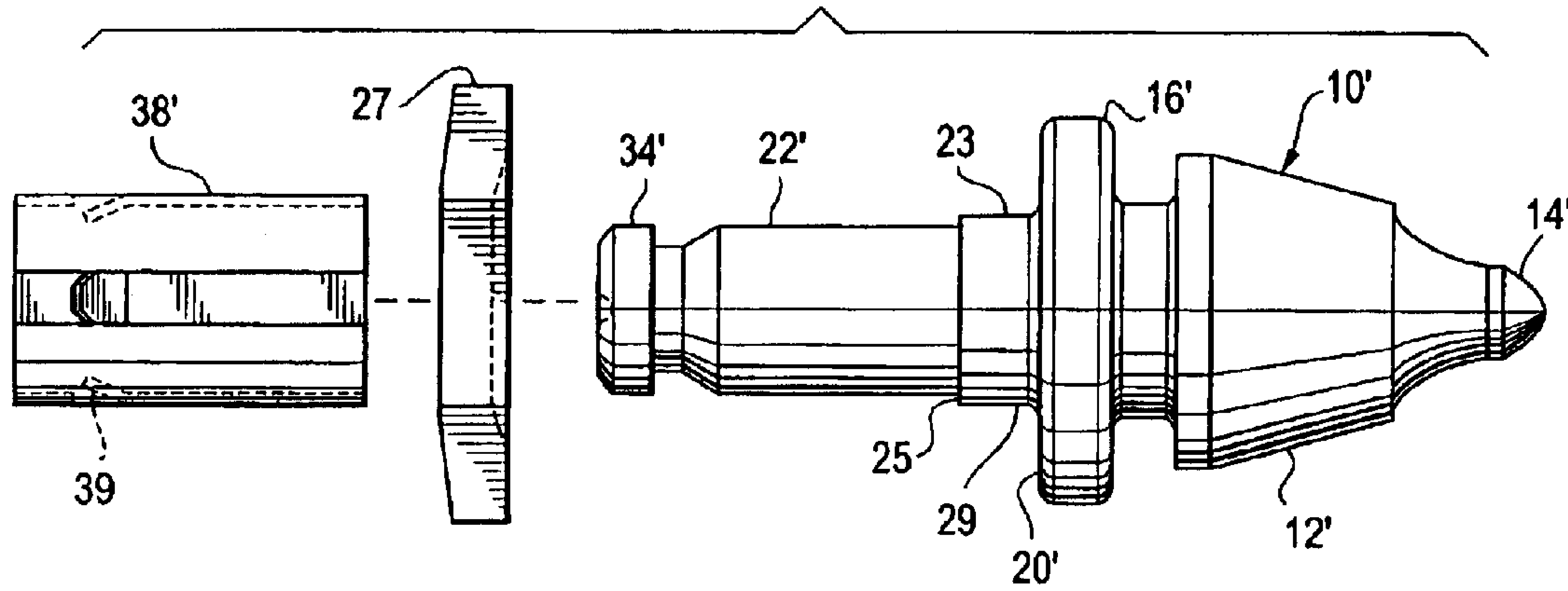

Fig. 3A
PRIOR ART

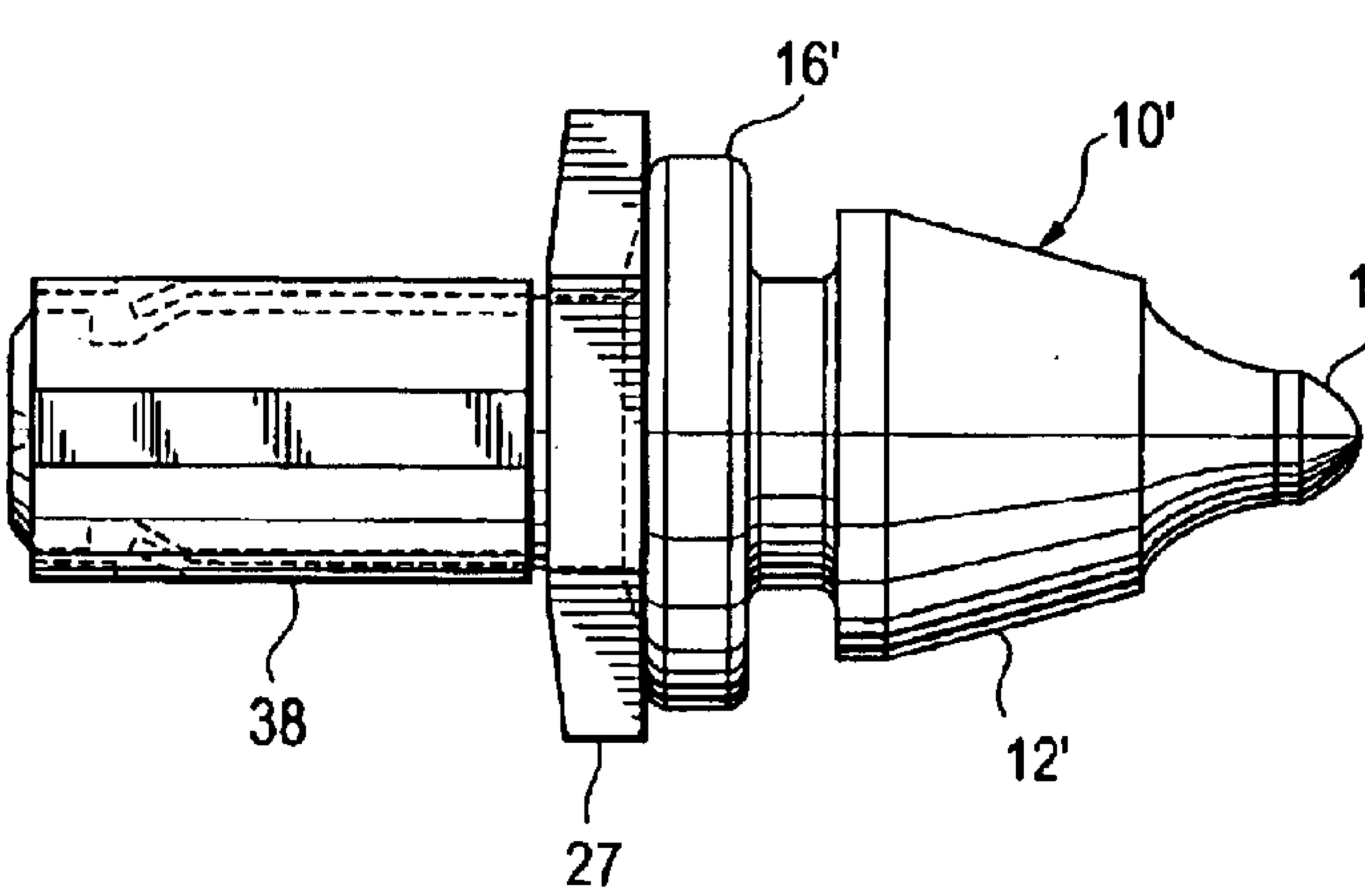

Fig. 4

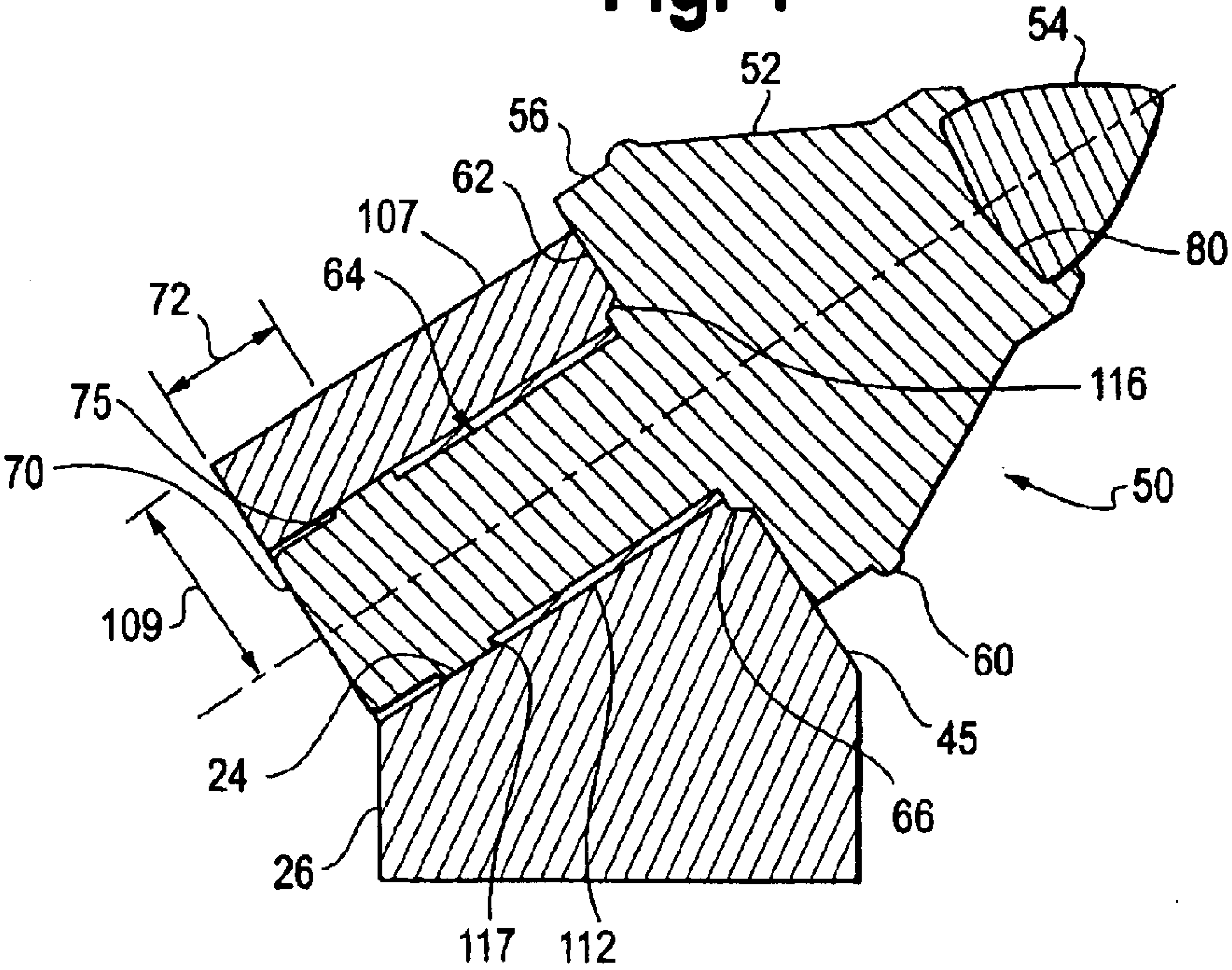
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Fig. 4A

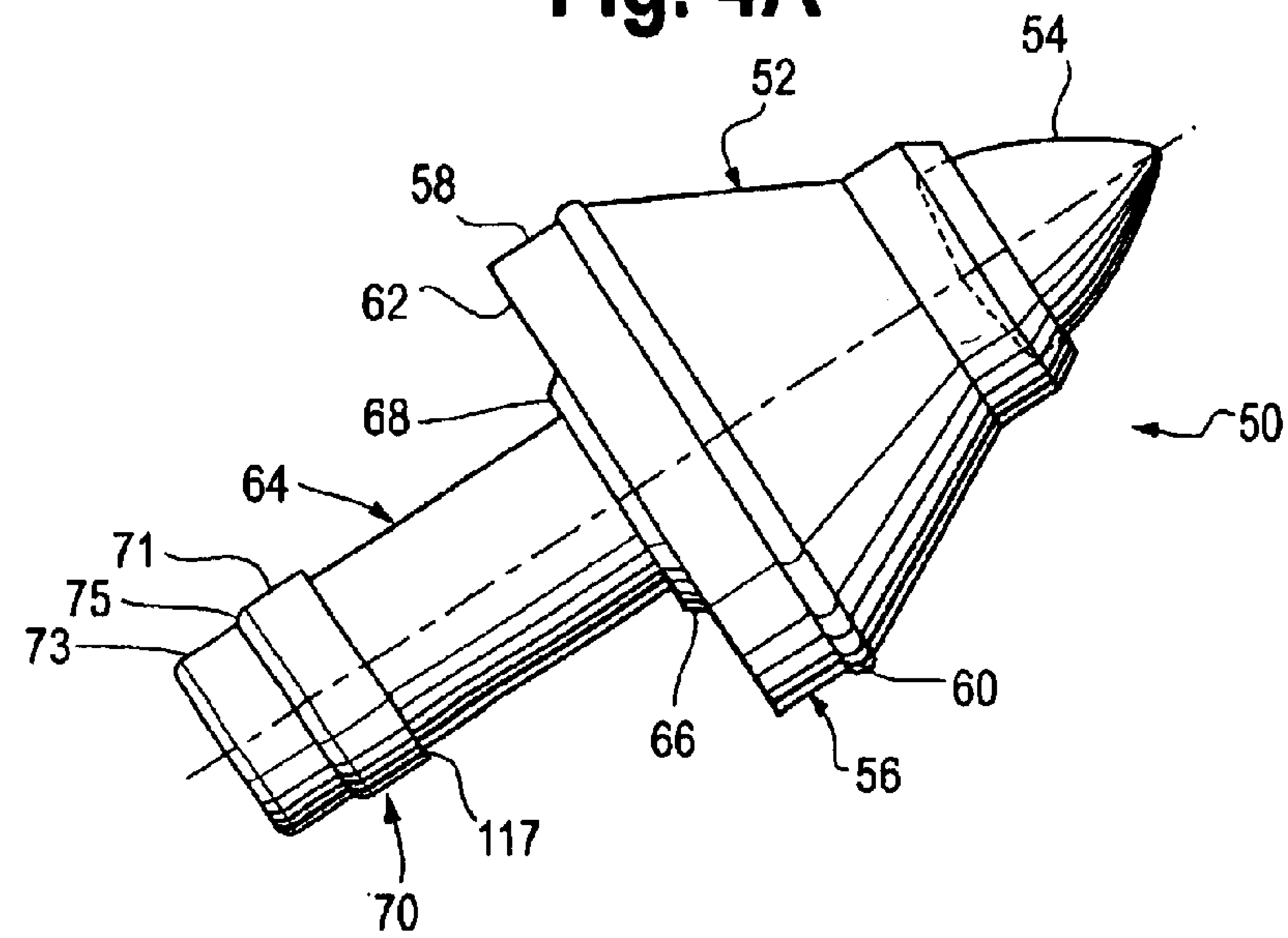
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Fig. 5

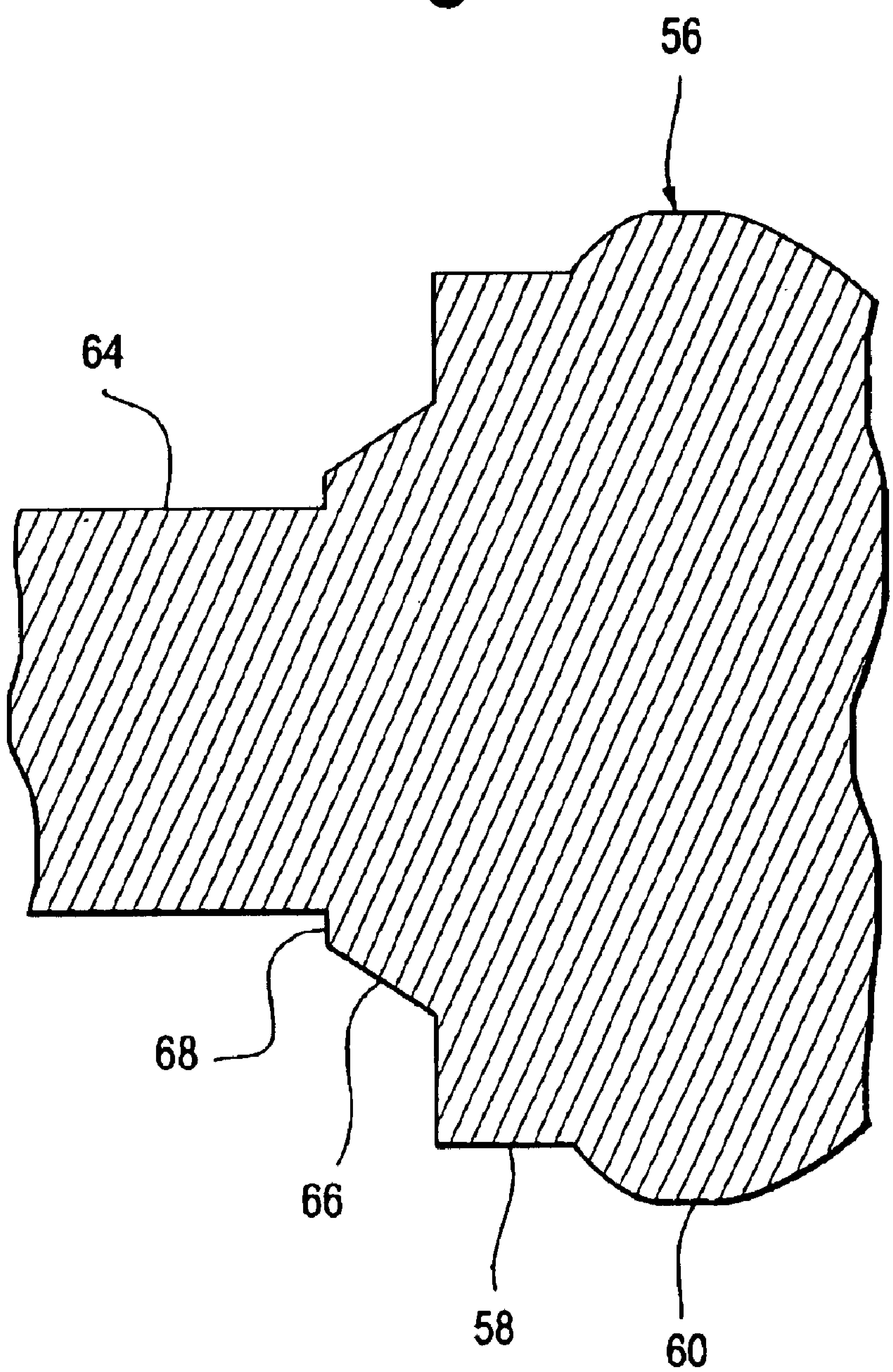


Fig. 6A

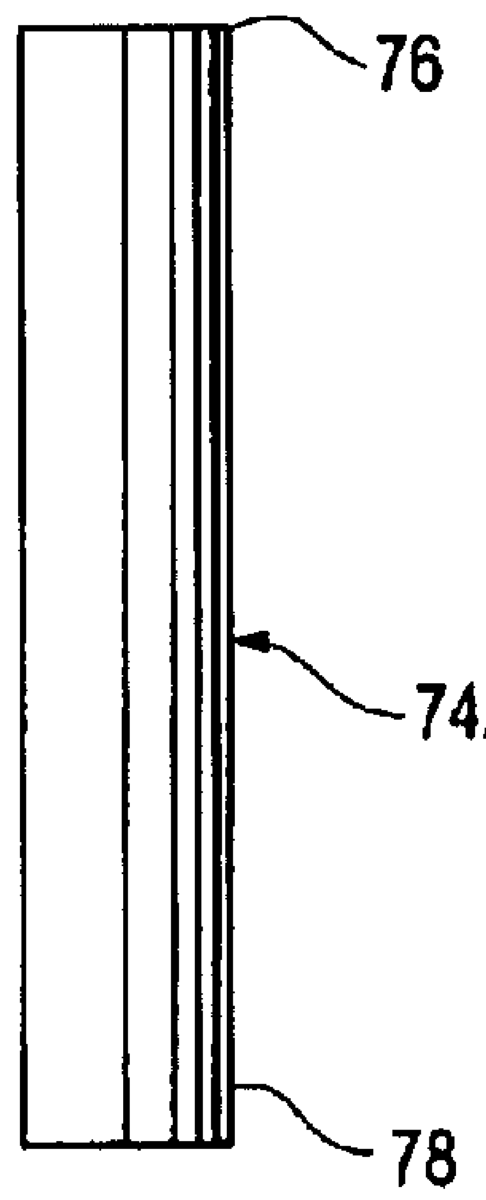
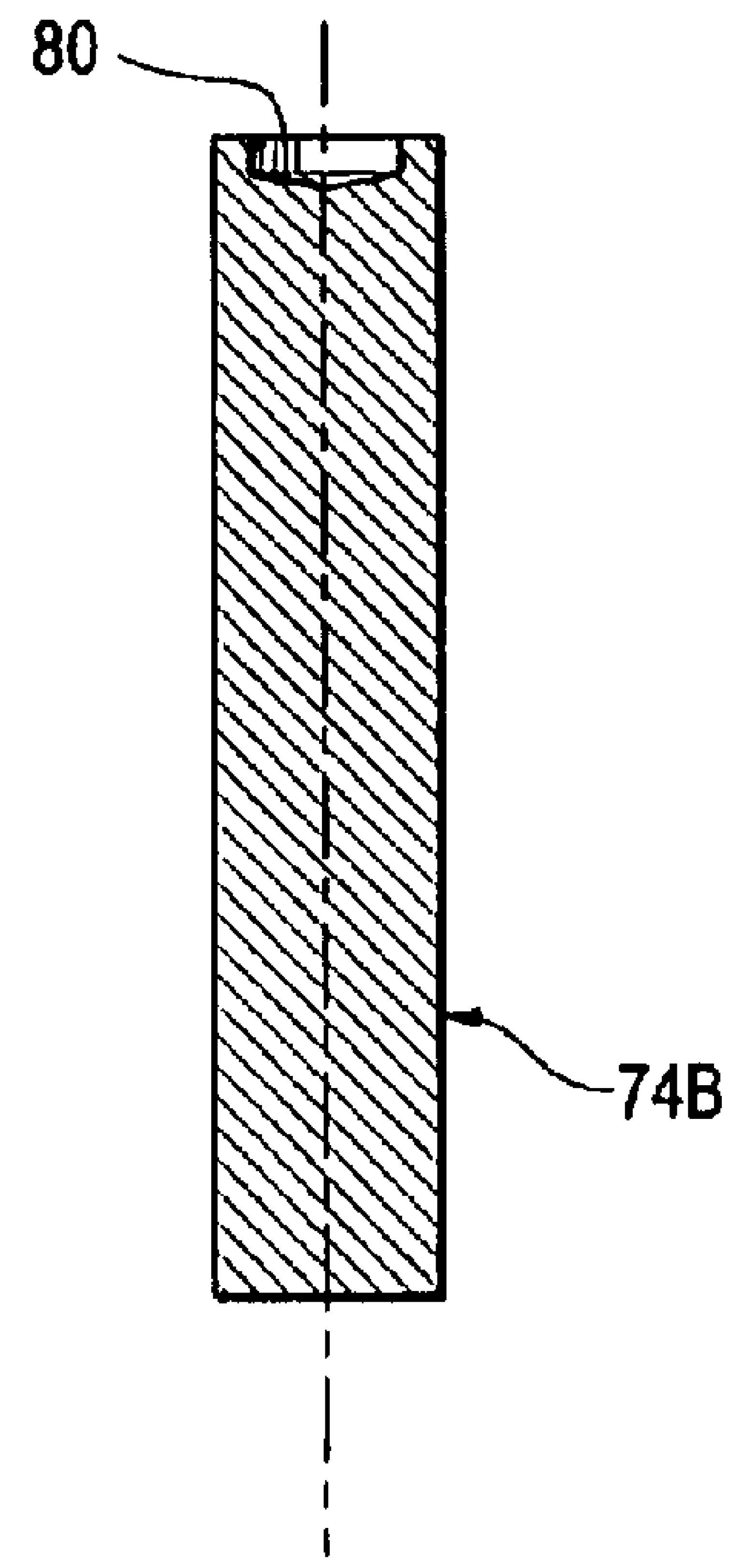


Fig. 6B



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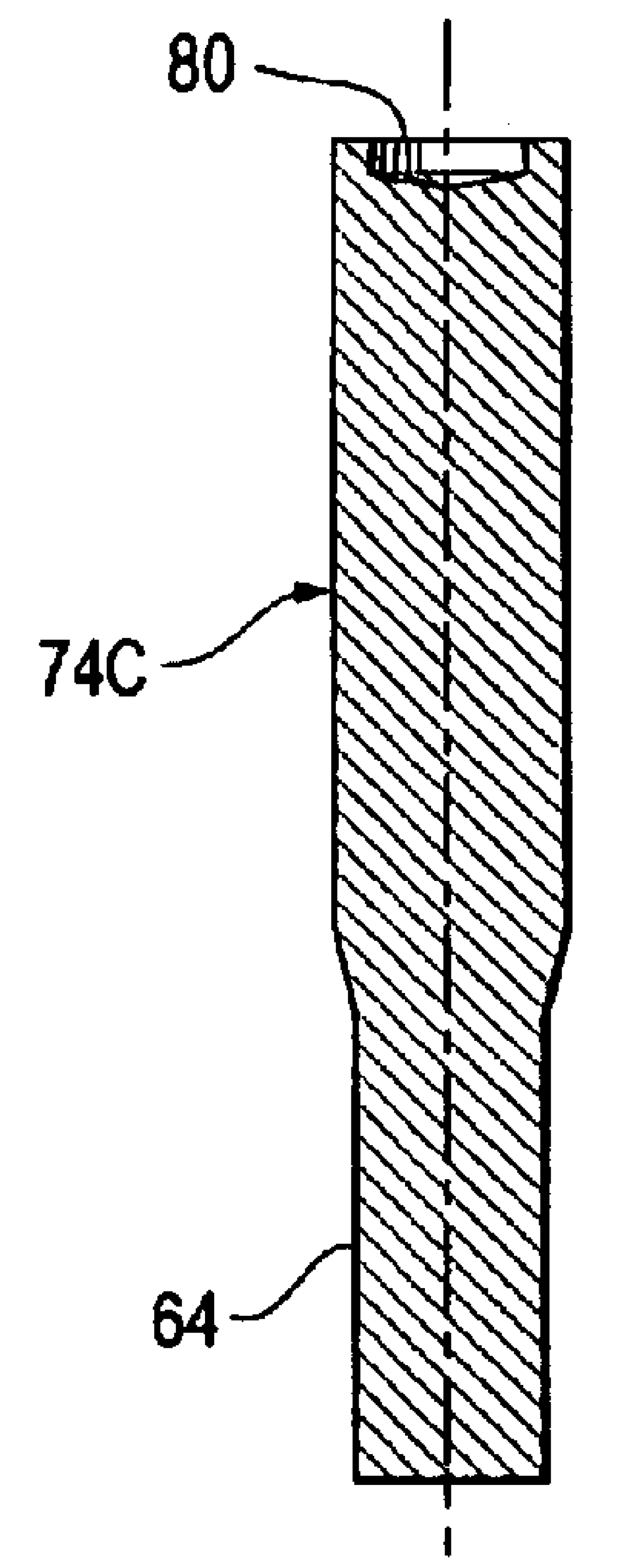

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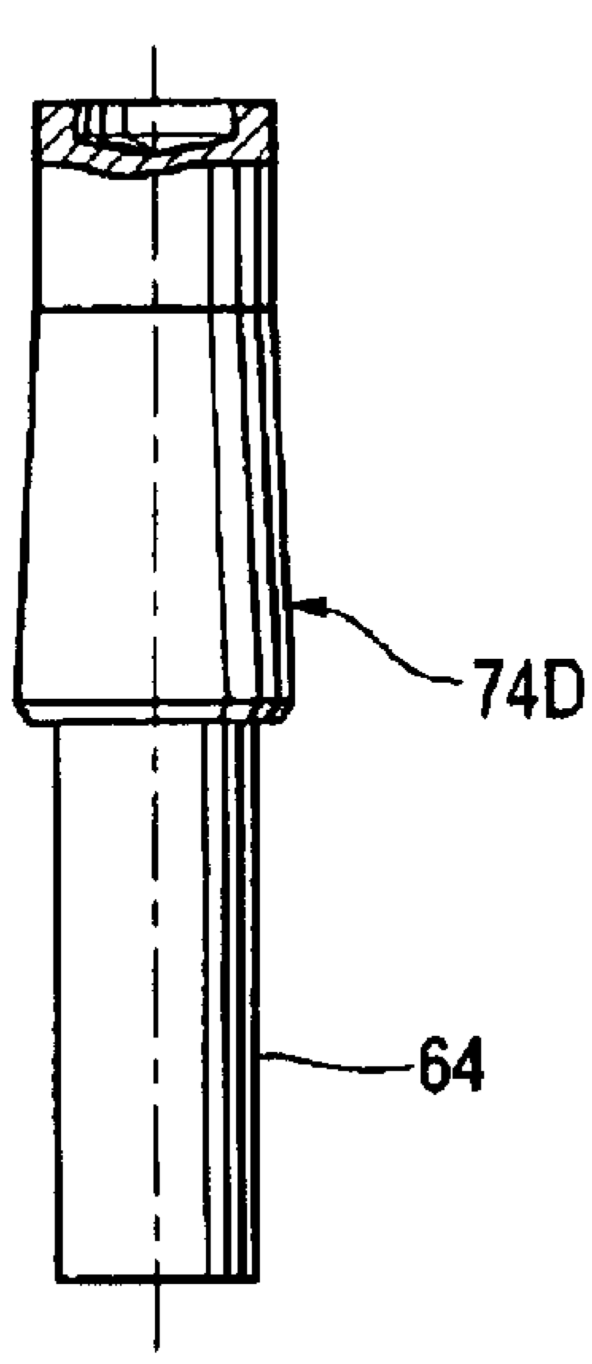

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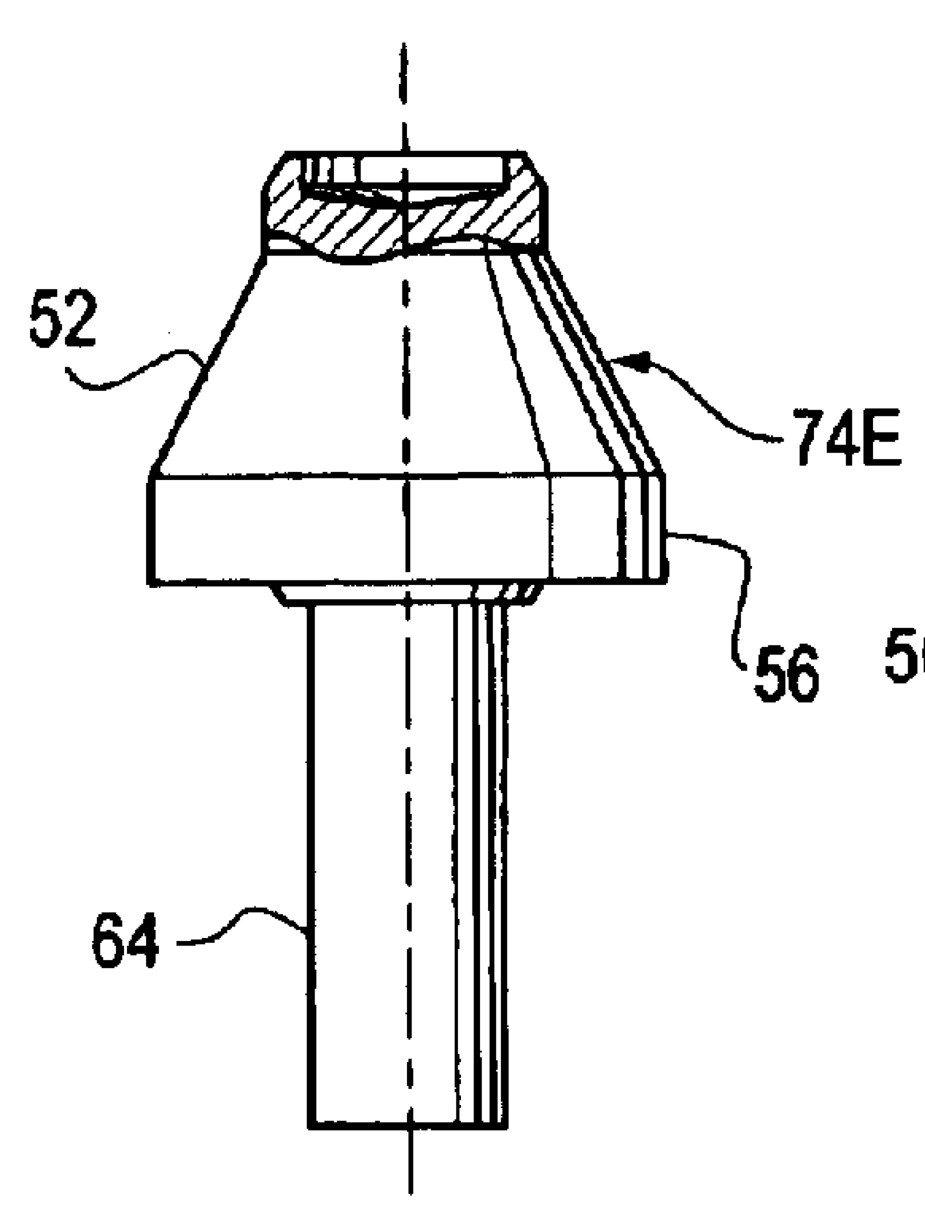

Fig. 6F

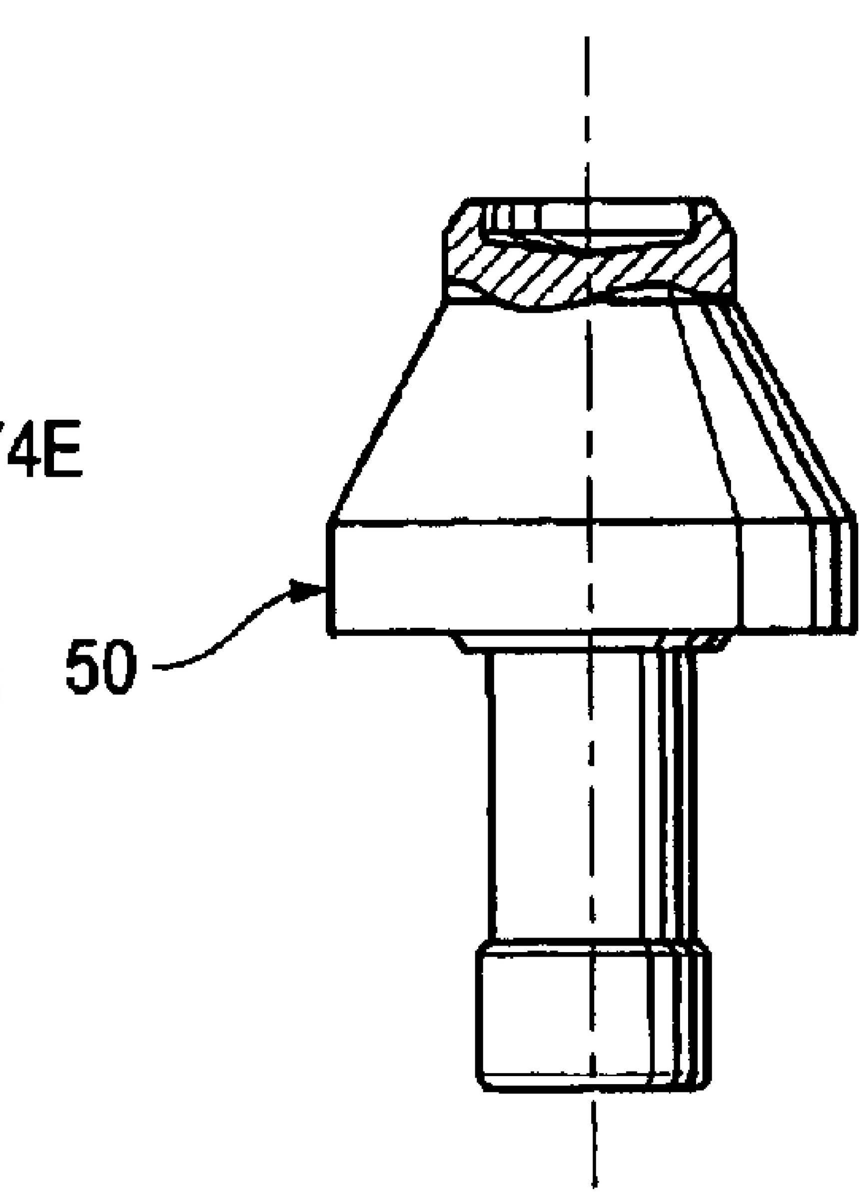

Fig. 7

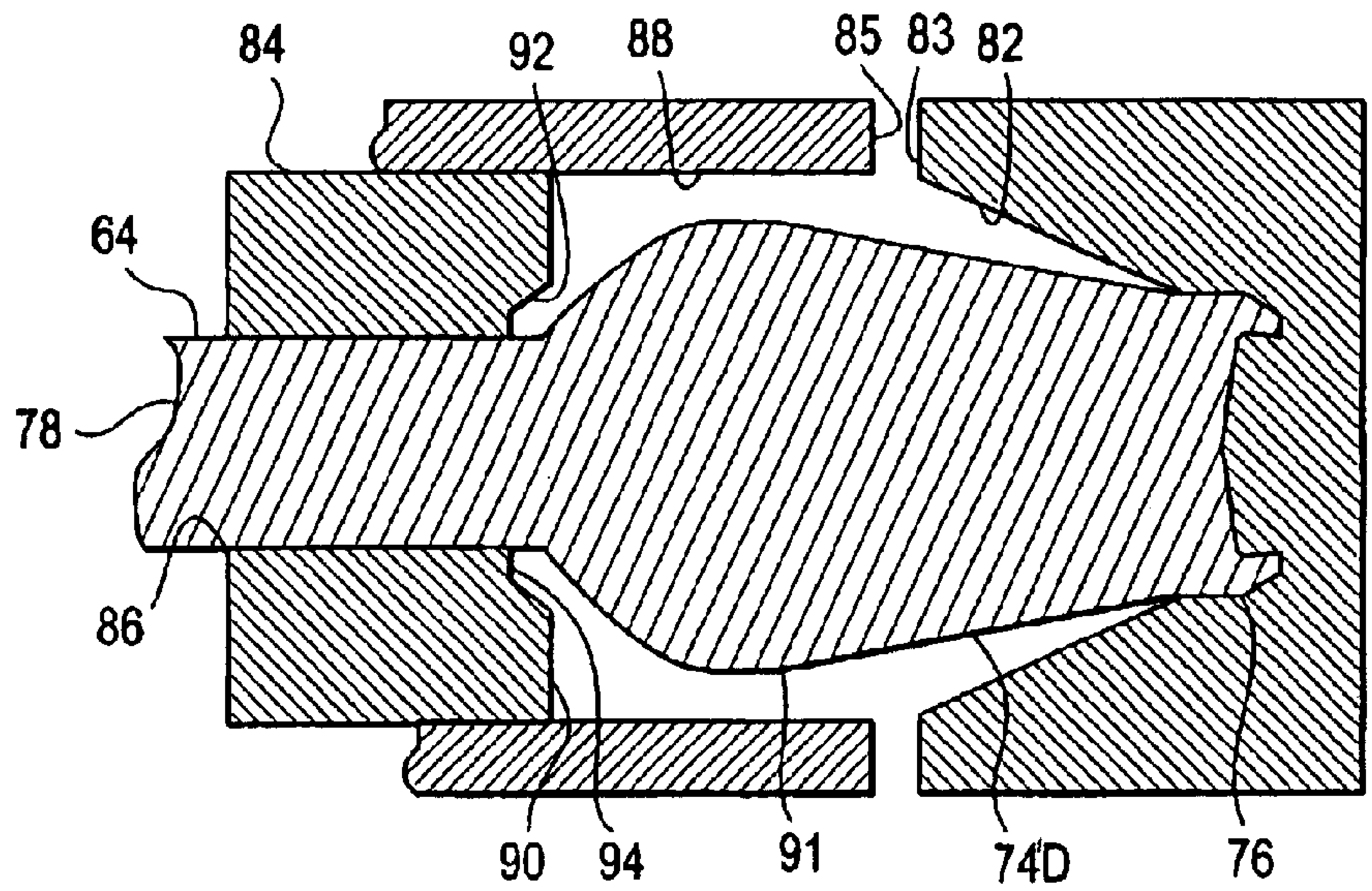
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Fig. 8

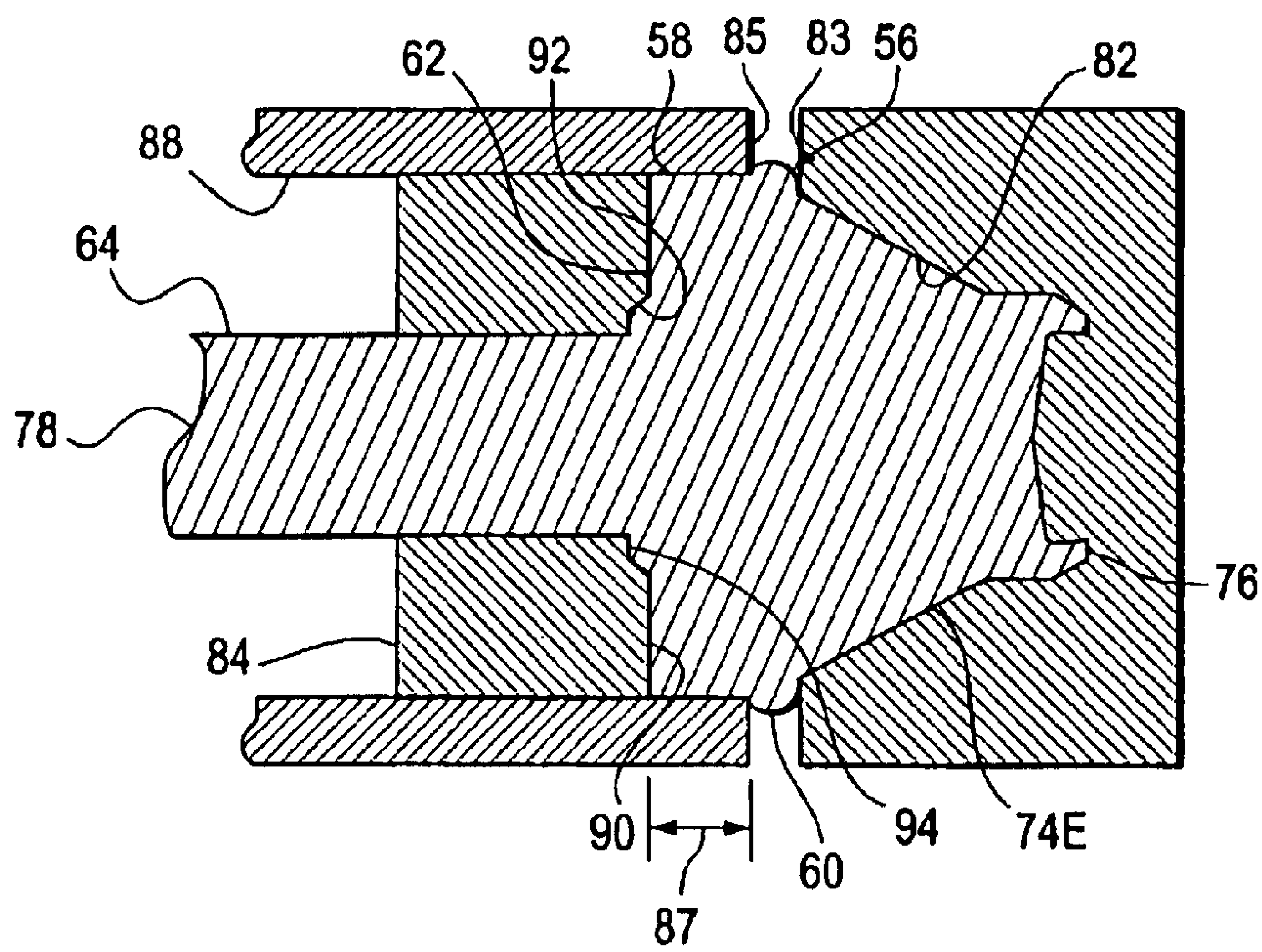
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Fig. 9
PRIOR ART

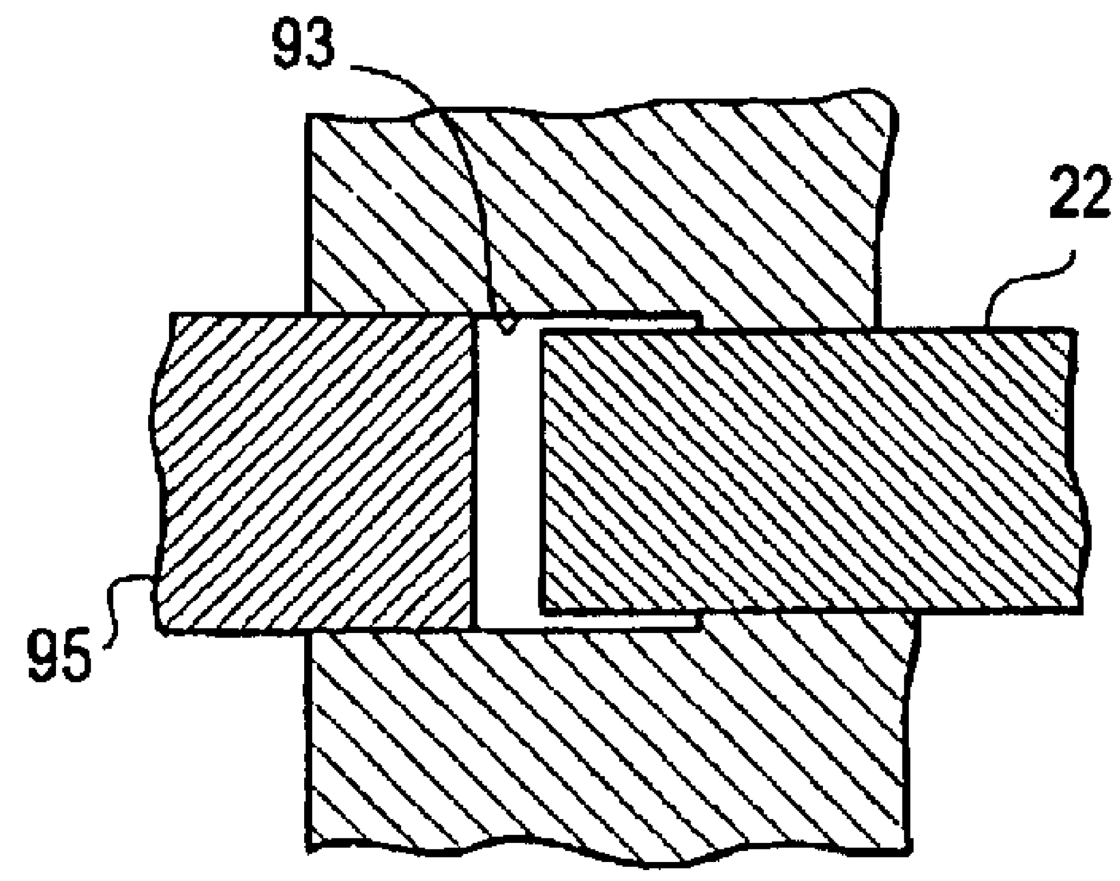

Fig. 10

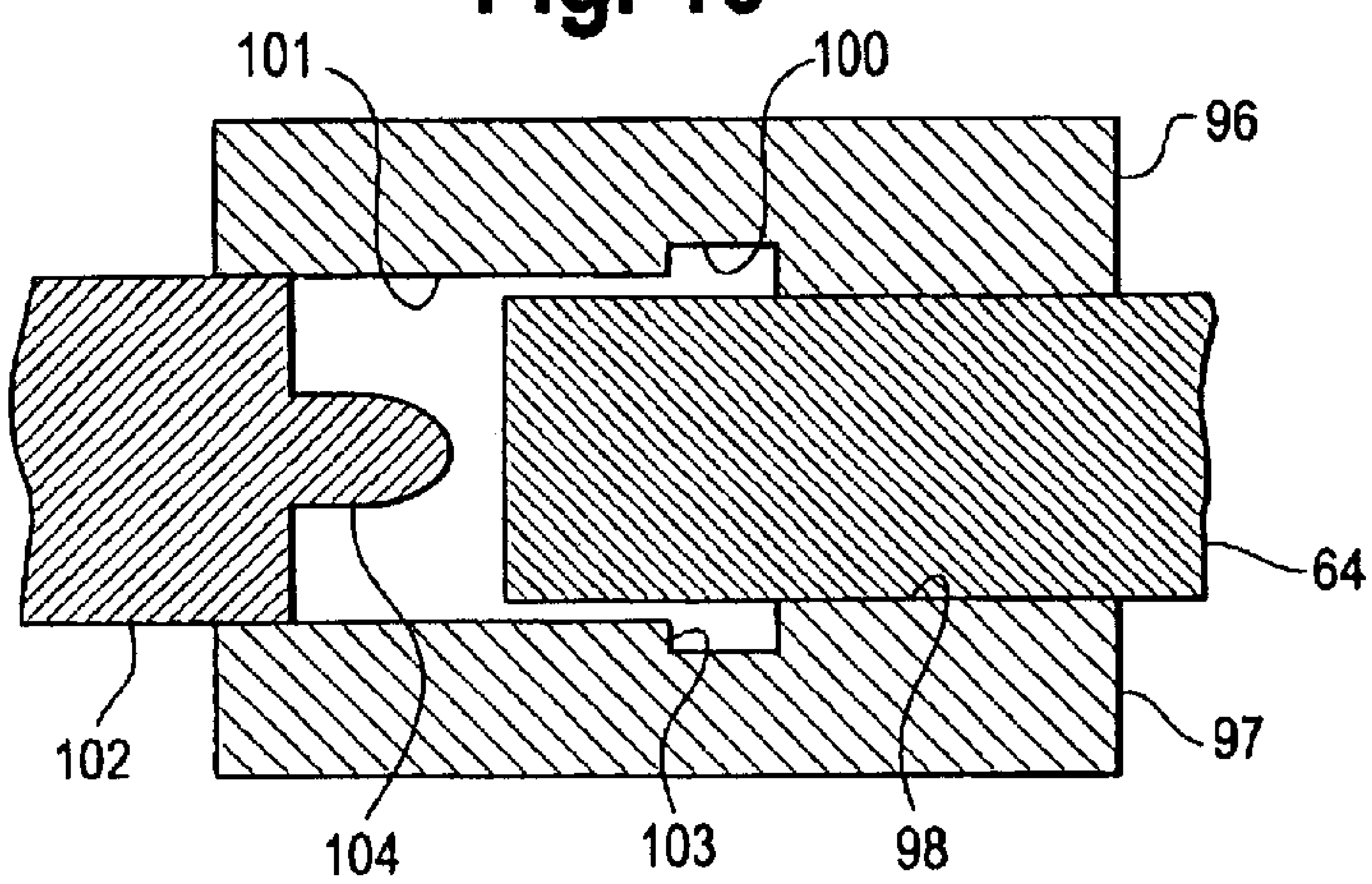

Fig. 11

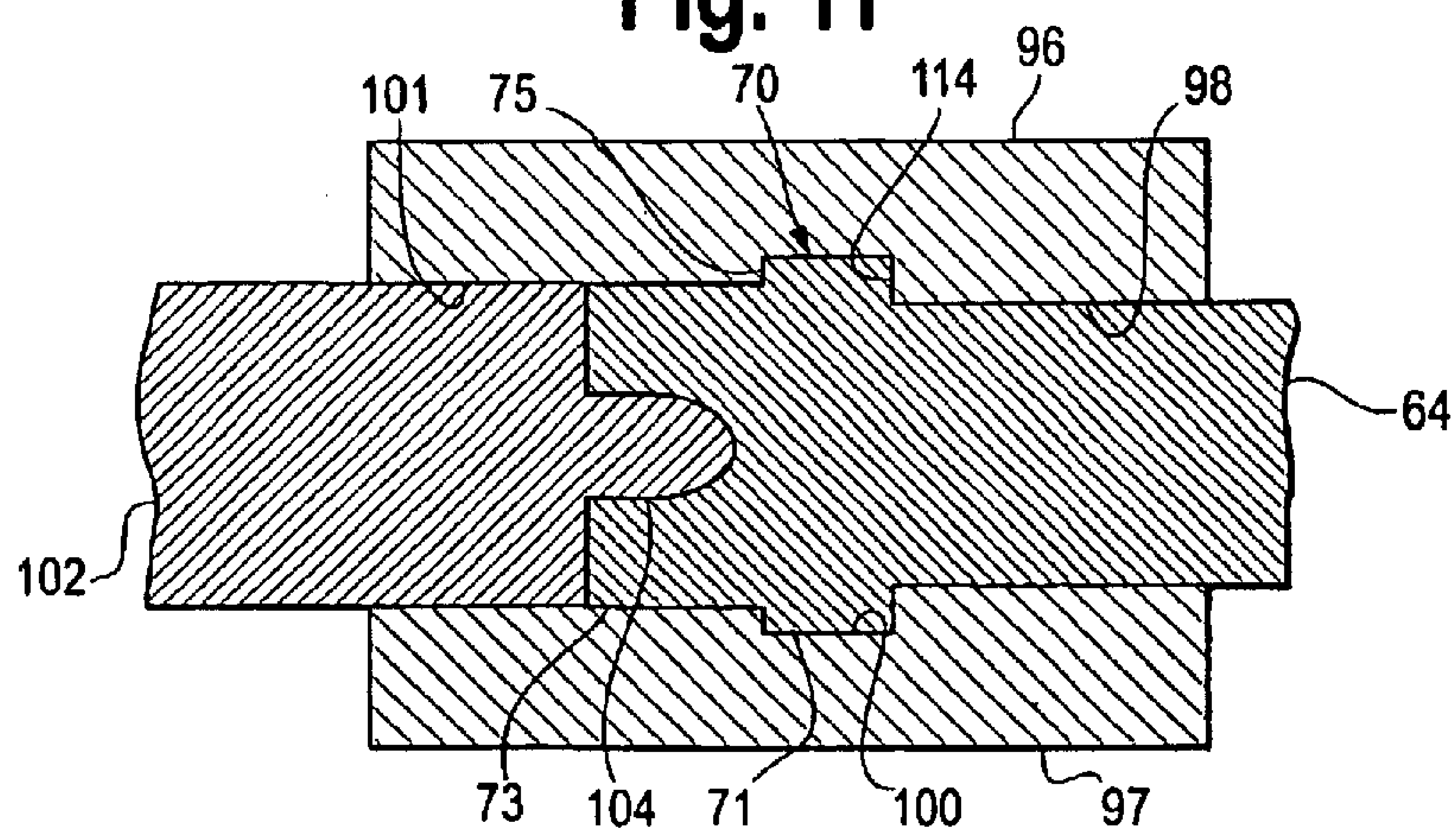

Fig. 12

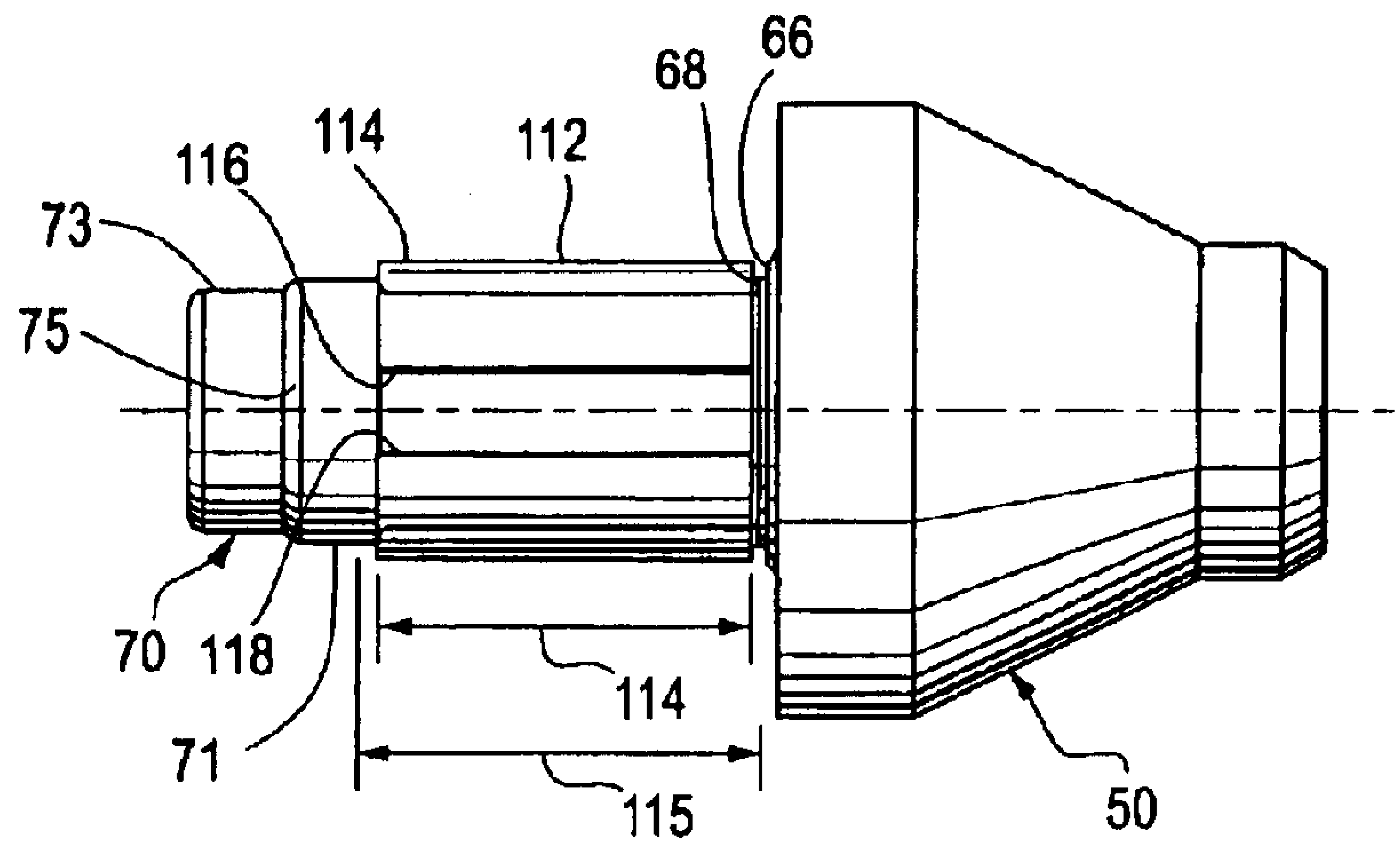
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Fig. 13

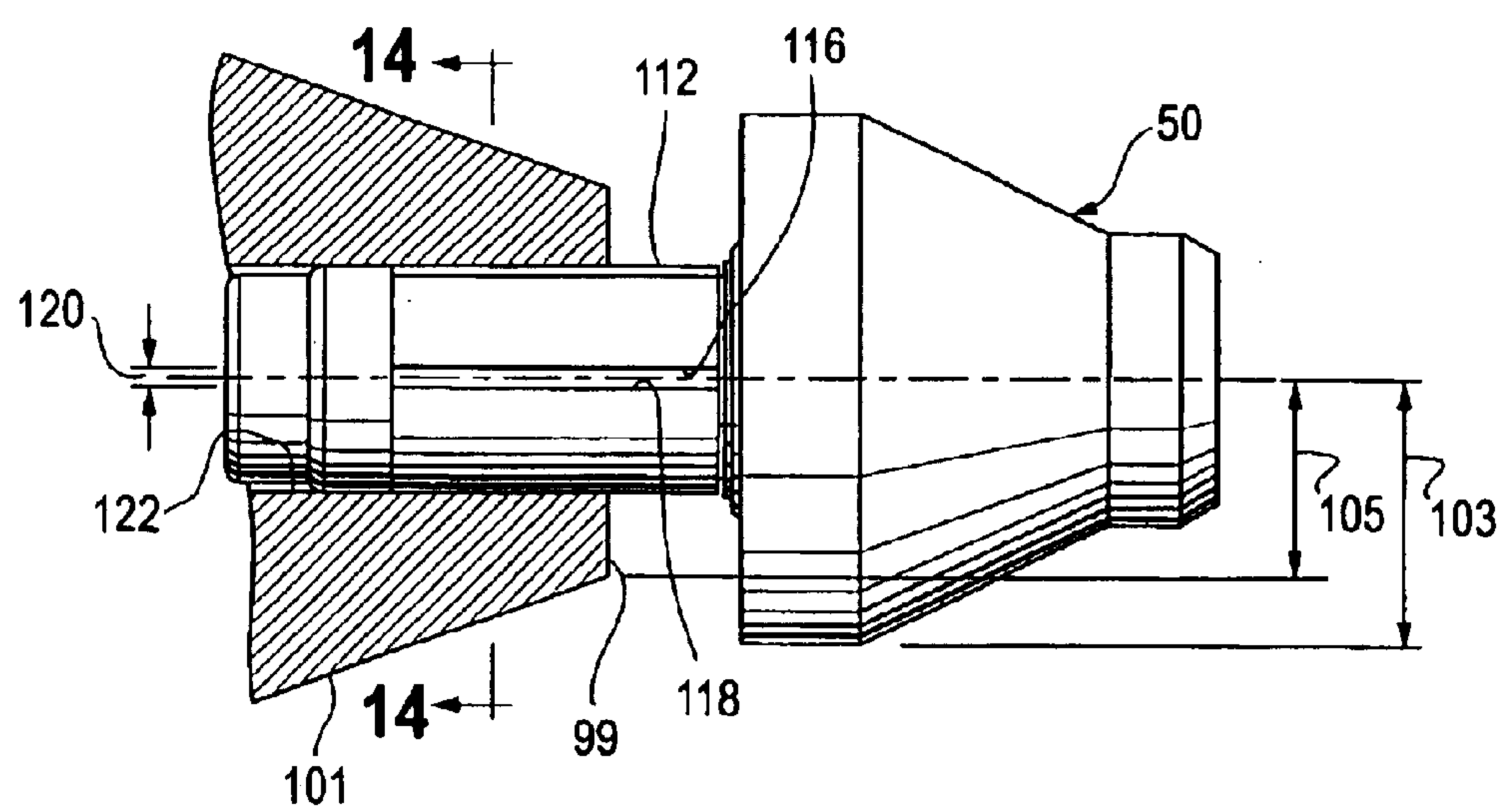
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Fig. 14

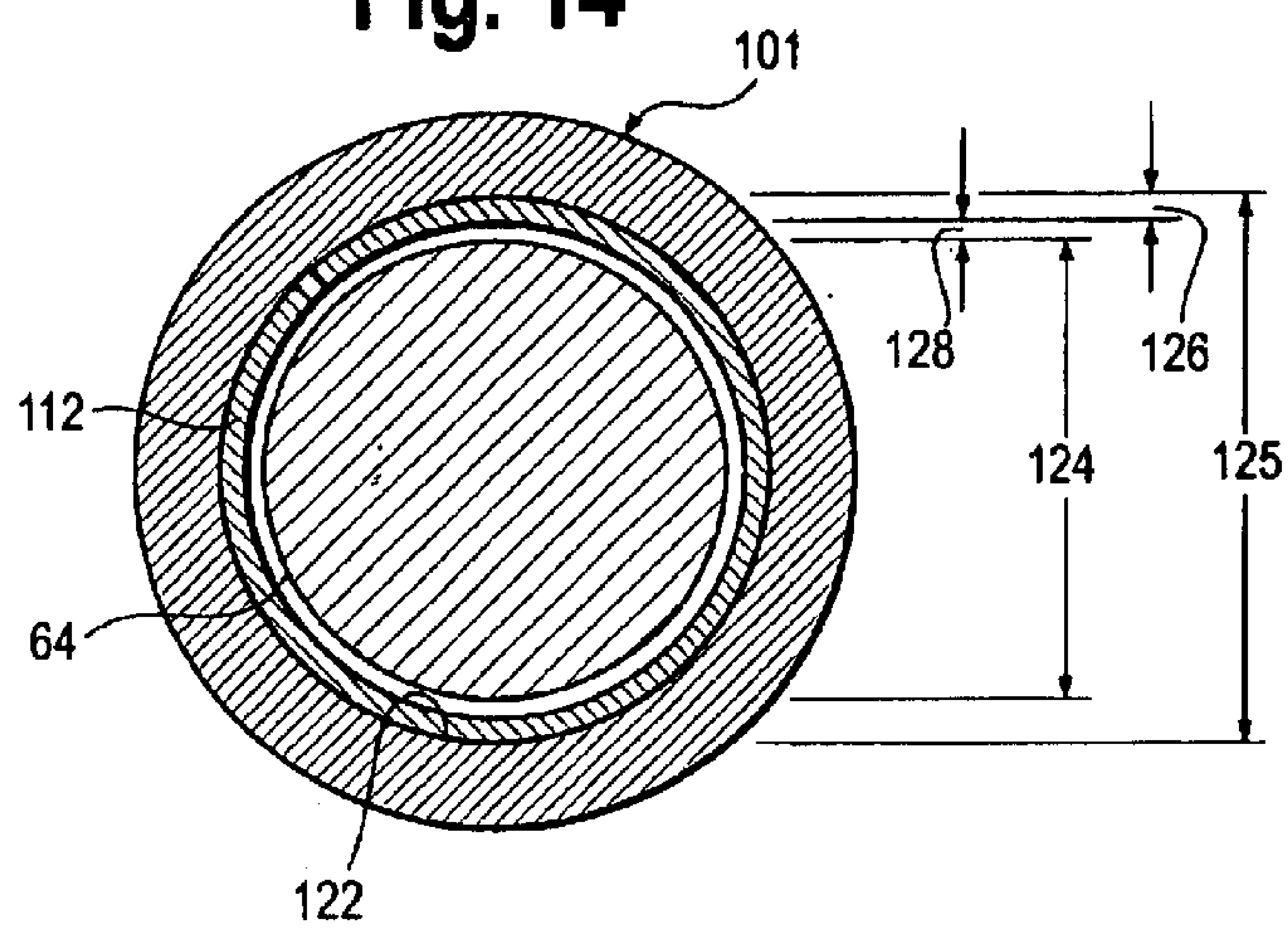


Fig. 15

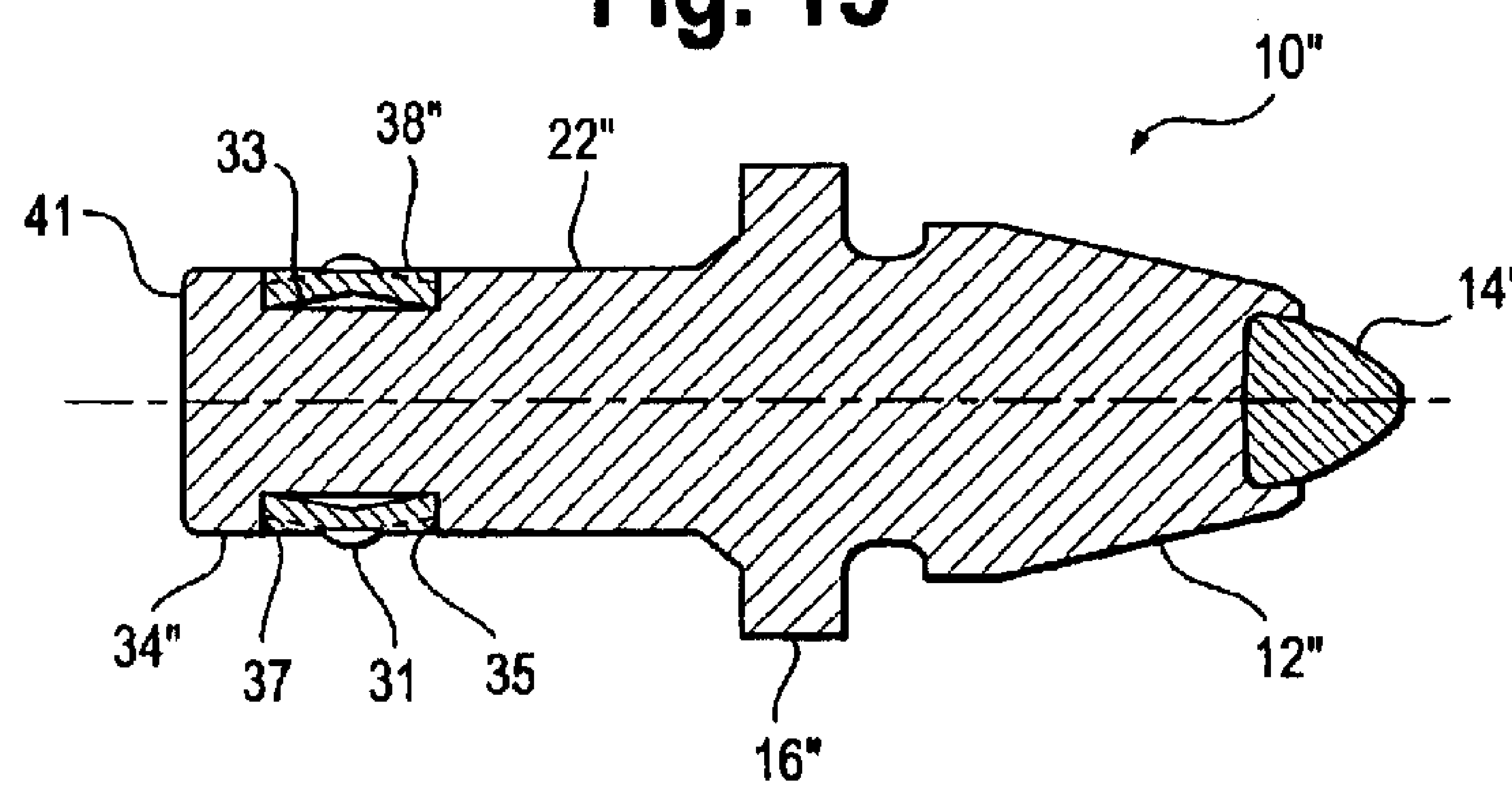
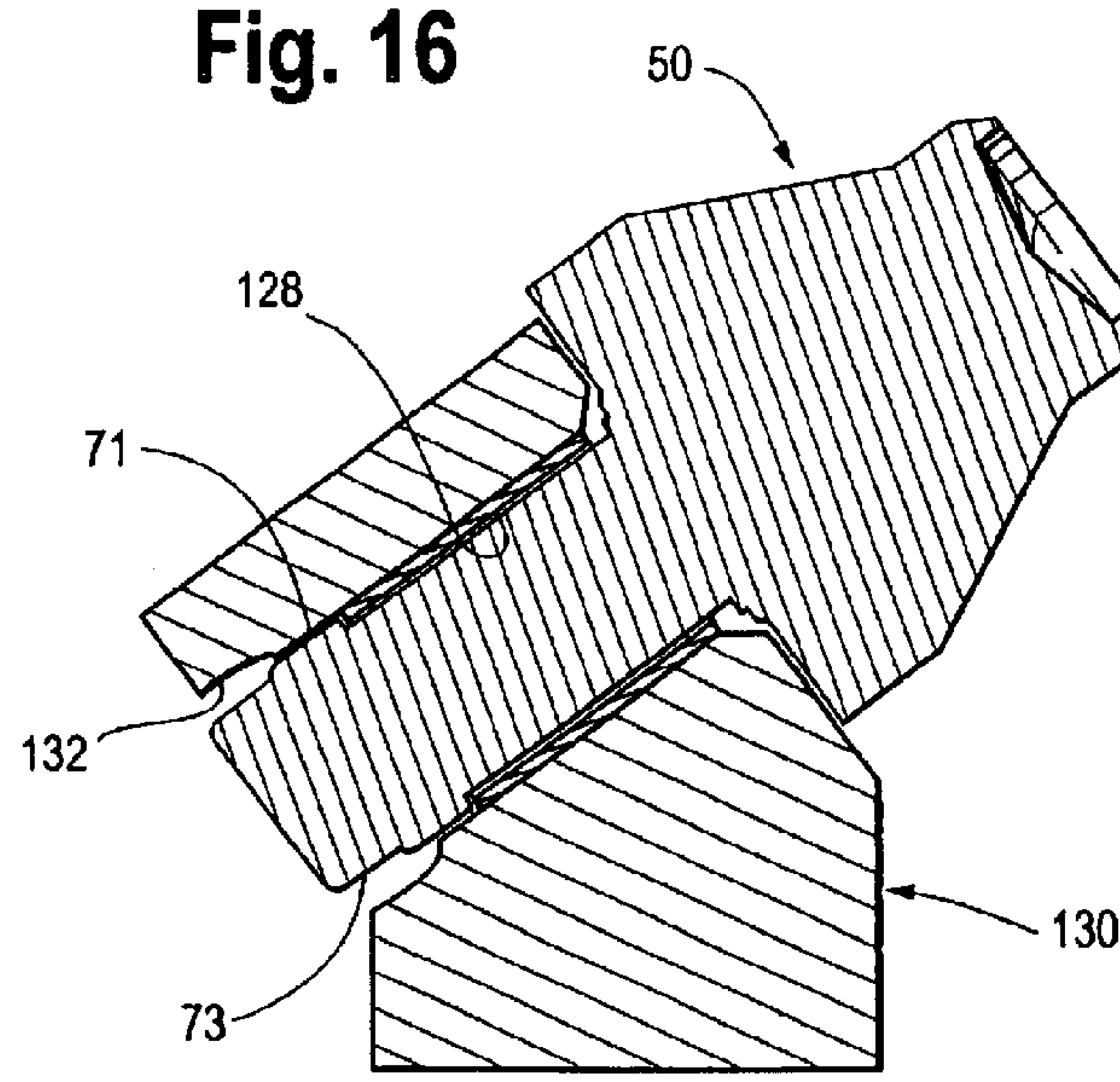


Fig. 16



TOOL BODY AND METHOD OF MANUFACTURE

This is a Continuation-in-part of my co-pending application filed Mar. 22, 2000 as Ser. No. 09/532,994 now U.S. Pat. No. 6,397,652. The present invention relates to rotatable tool bodies of the type mounted in a machine for cutting hard surfaces and, in particular, an improved method of cold forging such tool bodies.

BACKGROUND OF THE INVENTION

Machines for cutting hard surfaces, such as concrete and asphalt, provide for a rotating wheel or drum with a plurality of cuffing tools mounted around the circumference of the wheel or drum such that each tool cuts a small portion of the hard surface, thereby advancing the cut. The tools of such machines are symmetrical around a longitudinal axis and have a hardened cutting tip and a cylindrical mounting portion rotatably retained in a tool mount on the circumference of the wheel or drum such that the tool can rotate about its longitudinal axis. Rotation of the tool within the mounting member causes the tool to wear symmetrically and thereby increasing its useable life. The concrete and asphalt which is cut by such tools, however, is so abrasive that such tools nonetheless often become so worn in a single day's use that they must be replaced. The tools rarely survive two days of use.

To replace the tools of a cutting machine, the worn tool is removed from the tool holder after which a new tool is inserted therein. As many as six hundred replacement tools are required daily for a machine used to scarf the surface of a lane of pavement of highway. It is, therefore, desirable to maximize the useful life of such tools and to provide tools which are easily inserted into the holders thereof to reduce the down time required to replace the tools in the machine.

Existing cutting tools have a tapered forward cutting end with a tungsten carbide tip. Behind the forward cutting end is a radial flange and behind the flange is a cylindrical shank having a diameter sized to fit within the cylindrical bore of the tool holder. Between the shank and the radial flange is a frustoconical portion having a ramp angle of approximately 45° which facilitates the alignment of the tool within the tool holder. The cylindrical shank has an enlarged diameter hub at the distal end thereof and fitted around the shank, between the hub and the frustoconical portion, is a spring loaded sleeve biased to expand radially outwardly so as to bind against the inner surface of the bore in the holder and thereby retain the tool in the holder.

In use, the tool rotates within the spring loaded retaining sleeve around the shank and the rear surface of the radial flange rotates on the forward surface of the tool holder. The rotation of the radial flange of the tool on the forward surface of the tool holder causes the forward surface thereof to become worn away and, over a period of time, an indentation or a counterbore wears in the forward surface of the tool holder, the diameter of which is substantially equal to the outer diameter of the cylindrical radial flange. Over time, the counterbore within the forward end of a tool holder can be as deep as 3/16 of an inch.

When a replacement tool is inserted into the tool holder for which a counterbore has been worn into the forward surface thereof, the outer diameter of the radial flange of the replacement tool must rotatably fit within the inner diameter of the counterbore. If the outer diameter of the flange is equal to or larger than the inner diameter of the counterbore, it will bind against the inner surface of the counterbore and inhibit the rotation of the tool within the tool holder and thereby cause the tool to become prematurely worn. To prevent the outer circumference of such flange from locking within the counterbore in the tool block, it is desirable to provide tools for which the radial flanges thereof all have equal outer diameters. Such tools are presently cold formed using existing technology in which a metal blank is formed into the desired shape. Since the volume of the metal remains constant, cold forming require that the forming die include an opening through which excess metal can be released, and usually the portion having the largest diameter is chosen to receive the excess metal. Existing cold formed tools have an enlarge outer flange diameter which is irregular in shape because that is where excess metal is released. To insure that such radial flanges all have equal outer diameters, it is presently necessary to machine the outer circumferences of such flanges. The machining step, however, is expensive, and it would be desirable to manufacture tool bodies without requiring the machining of the outer circumference of the flange.

The rotatability of a tool within a tool holder is also reduced by resistance between the cylindrical shank and the spring loaded retaining sleeve. Although the sleeve is designed to be retained between the forward end of the hub and the frustoconical portion of the tool, if the sleeve is not properly positioned within the tool holder the forward end of the sleeve can become wedged against the frustoconical portion of the tool. The sleeve tends to ride up the 45 degree angle of the frustoconical section thereby increasing the friction between the parts.

Friction also occurs between the outer circumference of the hub at the distal end of the shank and the inner wall of the cylindrical bore into which the shank of the tool is fitted. When the tool is used to cut a hard surface, substantial forces are applied perpendicular to the longitudinal axis of the tool, and complimentary forces are applied between the inner surface of the cylindrical bore and the outer circumference of the hub. These transverse forces increase the resistance to rotation of the tool body within the tool holder and wear away the inner surface of the tool holder.

A third source of friction which reduces the rotatability of the tool is friction against the outer wall of the shank as it rotates within the retaining sleeve. As the tool is used, fine particles of hard material work their way under the radial flange and across the forward surface of the tool holder until they fall into the bore of the holder. Some of those particles work their way down the bore of the holder and between the outer wall of the shank and the inner wall of the retaining sleeve. Particles also enter from the rear of the tool holder, between the hub and the bore of the block and work their way between the shank and the retaining sleeve. Eventually the particles between the shank and the retaining sleeve form a paste of grit which binds between the parts and prevents rotation of the tool, and causes premature tool failure.

In my co-pending application, Ser. No. 09/121,726 filed Jul. 24, 1998, I disclosed an improved tool holder which resists wear from the rotation of the tool within the holder by providing a tungsten carbide wear ring in a countersink located in the forward and rearward ends of the bore of the tool holder. As further explained in my co-pending application, the coefficient of friction between the metal of the tool body and the surface of the tungsten carbide wear ring is less than the coefficient of friction between a tool body and the metal surfaces of existing tools, thereby facilitating rotation of the tool within the tool holder. Nonetheless, the friction between the outer circumference of the hub at the distal end of a tool body and the accumulation of particles within the parts also inhibits the rotation of the tool.

The replacement of tools in the tool holders of a machine is a very time consuming process because such machines typically retain 160 or more tools, each of which must be individually replaced. To replace the worn tools the tools must first be extracted from the bores of the tool holders, then the replacement tools are inserted. The tools are retained in the tool holders by expandable sleeves fitted around the shanks thereof and it is difficult to insert a replacement tool into the bore of the tool holder because the expanded sleeve defines a diameter larger than the diameter of the bore. To insert a tool in accordance with the prior art the tool must be first be axially aligned with the bore of the holder, then the forward end of the tool is pounded until the shank of the tool is fully driven into the bore.

It is difficult to insert the hubs of existing tools in the bores of tool holders because the diameter of the hubs are nearly equal to the diameter of the bore into which it is to be inserted. Also, the hubs of existing tools have short axial lengths which allows the axis of the tools to become misaligned with the axis of the tool body. When the forward end of a misaligned tool is pounded with a hammer the inner surface of the bore can be damaged, thereby shortening the useful life of the tool holder.

In view of the foregoing, it is desirable to provide an improved method of manufacturing an axially symmetric tool for use in such tool holders which can be manufactured without requiring the machining of the outer diameters of the radial flange thereof and which will be less susceptible to wear caused by the transverse forces applied to the hubs at the distal end of the shank of the tool. It would also be desirable to provide an improved tool body which will maintain a retaining sleeve around the circumference of the shank thereof without permitting the forward end of the retaining sleeve to engage the frustoconical surface between the shank and the radial flange thereof. It would also be desirable to provide a tool body which would reduce the amount of fine particles between the shank of the tool and the retaining sleeve. Finally, it would also be desirable to provide a tool which could be more easily inserted into a tool holder.

SUMMARY OF THE INVENTION

It is the present custom to cold form the tool bodies which are used in cutting machines for cutting hard surfaces. In this process, a coil of steel wire is cut into a blank, each of which is heated to an appropriate temperature, typically about six hundred degrees Fahrenheit, after which it is subjected to series of cold forming steps. In each of the steps of the manufacturing process, the blank is mechanically inserted into a die which defines a portion of the outer surface of the tool body after which a punch applies an impact to the blank, causing the outer surface of the blank to conform to the contour defined by the die. The blank is moved through a succession of such dies, during the course of which the first end thereof is tapered into a forward cutting end and the second end thereof is constricted into a cylindrical shank. The contouring of the first end into a tapered forward cutting end causes metal from the first end of the blank to be forced towards the center thereof. Similarly, the constriction of the second end into a cylindrical shank also forces excess metal towards the center of the blank. Existing cold forming machines form the radial flange by allowing excess metal moved during the cold forming process to accumulate in a bulge which becomes the flange. The bulge is forged into the flange, and some excess metal remains around the outer circumference of the flange after the tool is forged. It is this excess metal which is removed during the machining operation.

In accordance with the present invention, the die employed to define the rearward surface of the radial flange includes a cylindrical portion having an inner diameter equal to the desired outer diameter of the rearward 3⁄16 of an inch of the flange. When the blank is fitted into the die and the punch is impacted against the blank, the cylindrical portion of the die will shape the rearward portion of the radial flange into a cylindrical portion of the desired outer diameter with a length of about 3⁄16 of an inch. Excess metal or overfill is released forward of the cylindrical portion.

The die used to configure the rearward surface of the radial flange also configures a frustoconical portion between the cylindrical shank of the radial flange. In accordance another feature of the present invention, a shoulder is formed between the cylindrical shank and the frustoconical portion to thereby retain the retainer band around the smaller diameter portion of the shank and prevent the forward edge of the sleeve from engaging the ramp surface of the frustoconical portion.

To manufacture the hub at the distal end of the shank of existing tools the shank of the partially formed tool body is inserted into a die defining an enlarged diameter hub after which the distal end is "bumped," causing it to enlarge within the die and thereby form the hub. The "bumping" technique commonly used is suitable for creating a hub having an overall length of no more than 1⁄4 inch and, therefore, it is customary for the hubs of such tools to have a length of only about 3⁄16 inch.

I have found, however, that there are many advantages to providing a significantly longer hub for such tools. Where a tool body is made with the hub having a length longer than 1⁄4 inch, the side loads thereto created by the forces at the forward end of the tool are distributed over a larger surface area. The larger surface area reduces the resistance to rotation and a reduction in the wear caused to the inner surface of the cylindrical bore of the tool holders. Also, where the hub is significantly longer than existing hubs (prefferably a half inch in length as opposed to 3⁄16 inch for existing hubs), the distal end of the hub can be tapered or made with a narrower diameter than the forward portion of the hub. A hub with a smaller diameter distal end is significantly easier to insert into the bore of a tool holder than is a hub having a diameter sized to fit snuggly against the cylindrical walls thereof. With a smaller diameter at the distal end of the hub, the hub of the tool is more easily inserted into the bore of a tool holder. The longer length of the hub also assists in axially aligning the tool with respect to the bore, thereby greatly reducing tool replacement time. It is common to replace all the tools in a machine at the end of a workday, which in the past has been a time consuming process because such machines can carry as many as 500 tools.

I have found that a hub having a longer length can be cold formed by providing a suitable die for an elongated hub and providing a punch having a generally conically shaped forward end for impacting against the distal end of the shank. When the conical punch is impacted axially into the distal end of the cylindrical shank, the forward end of the die extends into the metal of the shank. As the conical punch enters the distal end of the shank, radial forces are applied to the metal of the shank surrounding the conical protrusion. These radial forces applied from within the shank cause the metal of the distal end of the shank to fill the cavity of the enlarged die thereby forming an elongated hub.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the present invention will be had after a reading of the following detailed description taken in conjunction with the following drawings wherein:

FIG. **1** is a cross sectional view of a tool body manufactured in accordance with the prior art showing the tool retained in a tool holder;

FIG. **1**A is a second cross sectional view of the tool body shown in FIG. **1** free of the tool holder and without a tungsten carbide insert;

FIG. **2** is a fragmentary cross sectional view of the punch and die required to form the radial flange of a prior art tool body such as shown in FIGS. **1** and **2**;

FIG. **3** is an exploded view of a second embodiment of a tool body and a retaining sleeve for retaining the tool in a tool holder in accordance with the prior art;

FIG. **3**A is an assembled side elevational view of the tool and retaining sleeve shown in FIG. **3**;

FIG. **4** is a cross sectional view of a tool in accordance with the present invention retained in a tool holder;

FIG. **4**A is a second cross sectional view of the tool body shown in FIG. **4** free of the tool holder and without a tungsten carbide insert;

FIG. **5** is a fragmentary enlarged cross sectional view of the tool shown in FIG. **4**;

FIG. **6**A is a side elevational view of a cylindrical blank that has been cut to size in the first station of a cold forming machine;

FIG. **6**B is a cross sectional view of the blank of FIG. **6**A after it has been formed in the second station of the cold forming machine;

FIG. **6**C is a cross sectional view of the blank of FIG. **6**B after it has been formed in the third station of the machine;

FIG. **6**D is a side elevational view taken partially in cross section of the blank of FIG. **6**C after it has been formed in the fourth station of the machine;

FIG. **6**E is a side elevational view taken partally in cross section of the blank shown in FIG. **6**D after it has been formed in the fifth station of the machine;

FIG. **6**F is a side elevational view of the finished tool body after being formed in the sixth station of the machine;

FIG. **7** is a cross section view with the forward end in cross section of a punch and a first and second die suitable for forming a radial flange in accordance with the present invention fitted around a partially formed blank of a tool body before the punch is impacted against a blank;

FIG. **8** is a cross sectional view of the punch and dies shown in FIG. **7** after the punch is impacted against a blank;

FIG. **9** is a cross sectional view of the punch and die for forming an elongate hub positioned at the distal end of a shank of a partially formed tool body in accordance with the prior art;

FIG. **10** is a cross sectional view of the punch and die for forming an elongated hub at the distal end of a shank in accordance with the present invention;

FIG. **11** is a cross sectional view of the punch and die shown in FIG. **10** after the punch has been struck;

FIG. **12** is a side elevational view of a tool body in accordance with the invention having a sleeve fitted around the shank thereof;

FIG. **13** is a fragmentary cross sectional view of the tool mounting having a tool and the retaining sleeve shown in FIG. **12** partially inserted into the mounting block;

FIG. **14** is an enlarged cross sectional view of the tool mounting and tool shown In FIG. **13** taken through line **14—14** thereof;

FIG. **15** is a cross sectional view of a third embodiment of a tool body in accordance with the prior art; and

FIG. **16** is cross sectional view of a tool according to the invention inserted into a tool holder for which the rear end of the bore has been worn by the hubs of prior art tools.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. **1** and **1**A, a tool **10** in accordance with the prior art has a tapered forward cutting end **12**, at the forwardmost end of which is a tungsten carbide cutting tip **14** fitted into a seat **15**. Positioned rearward of the cutting end **12** is a radial flange **16** and cut into the outer surface of the cutting end **12** and forward of the flange **16** is an annual groove **18** for receiving the jaws of an extractor tool for retracting the tool **10** from a tool holder **19** on a machine. The rearward surface **20** of the radial flange **16** is planar, and extending rearward from the flange **16** is a cylindrical shank **22** which extends within a cylindrical bore **24** of a tool holder **19**. Between the cylindrical shank **22** and the planar rearward surface **20** of the radial flange **16** is a frustoconical portion **28** having an incline of approximately forty-five degrees with respect to the axis **30** of the tool **10**. The frustoconical portion **28** provides strength to the union of the shank **22** to the rear surface **20** of the flange **16** and fits within a frustoconical portion **32** of the holder **19** to aid in the alignment of the tool **10** within the tool holder **19**. At the distal end of the cylindrical shank **22** is a cylindrical hub **34**, the forward end of which defines a shoulder **36**.

Fitted around the circumference of the cylindrical shank **22** is a retaining sleeve **38** made of a spring steel, spring loaded to urge the sleeve to expand radially outwardly to compress the outer surface thereof against the inner surface of the cylindrical bore **24** of the tool holder **19**. The cylindrical shank **22** of the tool **10** is retained in the bore **24** by the shoulder **36** engaging the rearward edge of the retaining sleeve **38**.

To maximize the useful life of the tool **10**, it is desirable that the tool **10** rotate round its longitudinal axis **30** with the shank **22** rotating within the retaining sleeve **38** fitted in the cylindrical bore **24**. Resistance to rotation of the tool **10** within the sleeve **38** can cause a flat to be worn on the surface of the carbide **14** and cause the tool to become prematurely worn, thereby shortening its useful life. Friction which inhibits rotation occurs between the rearward surface **20** of the radial flange **16** and the forward surface **44** of the mounting block **19**, between the outer surface of the shank **22** and the inner surface of the retaining sleeve **38**, and between the outer surface of the hub **34** and the inner surface of the cylindrical bore **24**.

In the event the retaining sleeve **38** is not fitted entirely within the bore **24**, the forward edge of the retaining sleeve **38** can become wedged between the frustoconical portion **28** of the shank **22** and the complimentary frustoconical portion **32** of the tool holder **19** and thereby substantially increase friction and inhibit the rotation of the tool **10**. Also, the rotation of the radial flange **16** against the forward surface **44** of the tool holder **19** can wear a counterbore **46** in the forward surface **44**. When the tool **10** becomes worn and a new tool **10** is inserted therein having a radial flange **16** with an outer circumference which is larger than the inner circumference of the counterbore **46** the flange **16** the replacement tool **10** will bind against the counterbore **46** and inhibit the rotation of the tool **10**. To prevent such binding, the outer circumference of the flange **16** is machined such that all flanges **16** have a common diameter.

Referring to FIGS. **3** and **3**A, in another embodiment of the prior art a tool **10'** has a forward cutting end **12'** with a tungsten carbide tip **14'**. Rearward of the cutting end **12'** is a radial flange **16'** and rearward of the flange **16'** is a cylindrical shank **22'**. In this embodiment the shank **22'** has an enlarged diameter forward portion **23** with a shoulder **25** formed between the shank **22'** and the forward portion **23**. A groove **29** near the distal end of the shank defines a hub **34'** having a diameter equal to that of the central portion of the shank **22**.'A spring loaded sleeve **38'** having a plurality of detents **39** which engage the groove **29** is fitted around the shank **22'** to retain the shank **22'** in the bore of a tool holder (not shown). In this embodiment, an annular wear washer **27** is fitted around the forward portion **23** of the shank **22** such that the forward surface thereof abuts the rear surface **20'** of the flange **16'** and the rear surface of washer **27** rests on the forward surface of the tool holder (not shown).

The washer **27** is replaced each time the tool **10'** is replaced. In this embodiment, the flange **16'** of the tool **10'** rotates on the forward surface of the washer **27** and therefore a counterbore, such as counterbore **46** described with respect to FIG. **1**, is not worn into the forward surface of the mounting block. In this embodiment, a small radius **29** is positioned between the forward portion **23** and the rear surface of the flange **16'**.

Referring to FIG. **15** in which another prior art tool **10"** is shown where the parts that are like those of previously described embodiments bear like indicia numbers but are double primed. The tool **10"** has a cutting end **12"**, a tungsten carbide tip **14"**, a flange **16"** and a shank **22"**. Near the distal end of the shank **22"** is an annular groove **33** forming a forward shoulder **35** and a rearward shoulder **37**. The distal end **41** of the shank **22"** is cylindrical and has an axial length of about 3⁄16 inch. Fitted around the annular groove **33** is a retainer sleeve **38"** which is retained between the shoulders **35**, **37**. A plurality of protrusions **31—31** on the outer surface of the sleeve **38"** engage an undercut in the inner surface of the bore of a tool holder (not shown) to retain the tool **10"** in the holder.

Although the tools **10'** and **10"** served the same purpose as tool **10** and has numerous similarities to tool **10**, they offer different solutions to certain problems incurred by such tools. The present invention relates to tools of the type shown in FIGS. **1** and **1A** as opposed to tool **10'** and **10"** shown in FIGS. **3**, **3A**., and **15**.

Referring to FIGS. **4**, **4A** and **5**, a tool **50** in accordance with the present invention has a forward cutting end **52** and a tungsten carbide tip **54**. Behind the cutting end **52** is a radial flange **56**. As further described below, during the course of cold forming the radial flange **56**, the rearward portion **58** thereof is constricted in a cylindrical die, having a fixed outer diameter such that the overfill **60** is released forward of the rearward portion **58** of the flange **56** as shown. The rearward surface **62** of the flange **56** is planar and extending rearward of the flange **56** is a cylindrical shank **64**.

As best shown in FIG. **5**, between the cylindrical shank **64** and the planar rear surface **62** of the flange **56** is a frustoconical portion **66**, and between the frustoconical portion **66** and the shank **64** is a shoulder **68**. The shoulder **68** assists in reducing resistance caused by the sleeve as further described below.

Referring further to FIGS. **4** and **4A**, at the distal end of the cylindrical shank **64** is a cylindrical hub **70** having an overall length **72** of about ½ inch. The hub **70** has a cylindrical forward portion **71** having a diameter a little smaller than inner diameter of the bore **24** of the tool holder **26** so as to rotatably fit therein and a cylindrical rearward portion **73** having a diameter a little smaller than that of the forward portion **71**. A shoulder **75** is formed at the junction between the portions **71** and **73**.

Referring to FIGS. **6A–6F**, the tool **50** is manufactured from a blank **74** consisting of length of steel having a specific diameter shown in FIG. **6A** which is subjected to a series of cold forming steps to shape the first end **76** into a tapered forward end **52** and to shape the second end **78** into a cylindrical shank **64** as shown in FIG. **4**. The process is carried out in a cold forming machine which is capable of subjecting a metal blank through a number of forming stages, or stations. In each of the forming stages the blank is placed into a die which defines the outer shape to be imparted to the blank, after which the blank is stricken with a punch. When the punch strikes the blank, the metal of the blank is forced against the boundaries of the die thereby altering its shape. FIGS. **6A** to **6F** depict the changes imparted to the blank **74** (the evolution of the blank being shown as **74A–74F**) as it moves through the six stages of a six stage cold forming machine.

Referring to FIG. **6A**, in the first stage a piece of cylindrical stock is sheared to the desired length to form the blank **74A**. In the second stage, shown in FIG. **6B**, a seat **80** is punched into the first end **76** to form blank **74B**. In the third stage, shown in FIG. **6C**, the second end **78** is constructed to form the shank **64** of blank **74C**. In the forth stage, shown in FIG. **6D**, the forward end of blank **74D** is partially formed. In the fifth stage, shown in FIG. **6E**, the balance of the forward cutting end **52** and the flange **56** are formed in blank **74E**, and in the sixth stage, shown in FIG. **6F**, the hub **70** is formed to complete the tool body **50**.

Referring to FIG. **2**, the flange **16** of a prior art tool body **10** is formed by first moving excess metal into the proximity of the flange **16** and then applying dies **77**, **79** to the forward and rearward surfaces thereof to give those surfaces the desired shape. A bulge **81** of excess metal accumulates between the two dies **77**, **79** and it is this bulge **81** that is subsequently machined to form the cylindrical outer circumference of the flange **16**.

Referring to FIGS. **7** and **8**, in accordance with the present invention, the fifth stage of the cold forming operation (the results of which are shown in FIG. **6E**) there is a first die **82**, having an inner surface shaped complimentary to the outer surface of the forward cutting end **52** of the completed body of the tool **50** into which the forward first end **76** is fitted as shown. A punch **84** has a cylindrical central opening **86** sized to receive the cylindrical shank **64** already formed at the second end **78** of the blank **74E**. The punch **84** moves within a second die **88** having a cylindrical inner surface for forming the cylindrical rearward portion **58** (best shown in FIG. **4A**) of the radial flange **56**. The punch **84** has an annular planar surface **90** complimentary to the planar rearward surface **62** (shown in FIG. **4A**) of tool **50**, and rearward of the planar surface **90** is a frustoconical surface **92** for shaping the frustoconical portion **66** (shown in FIG. **4A**) of the tool **50**. Between the frustoconical surface **92** and the cylindrical central opening **86** is an annular planar portion **94** complimentary in shape to the shoulder **68** (also best shown in FIG. **4A**). The first die **82** has a rearward surface **83** and the second die **88** has a forward surface **85** spaced a short distance from the rearward surface **83** of the first die **82** as shown.

When the punch **84** is struck against the rearward surface of the partially formed central portion **91** (FIG. **7**) of blank **74D**, it is shaped complimentary to the inner surface of the punch **84** and first and second dies **82**, **88**. After contacting the blank 74D, the punch 84 continues to move through the cylindrical die 88 until the parts have reached the configuration shown in FIG. 8. The punch 84 has a circumferencial edge which, at the end of the stroke of the punch, is spaced a distance 87 from the end 85 of the second die 88. In the preferred embodiment distance 87 is about 3/16 inch. As can be seen in FIG. 8, after the punch 84 is struck against the partially formed central portion 91 of the blank, excess metal or overfill 60 is released between the ends 83, 85 of the first and second dies 82, 88. Upon removal of the dies 82, 88 the bar stock 74E will be formed into the shape of the body of the tool 50, except for the formation of the hub 70 as shown in FIG. 6E.

The punch 84 and second die 88 are configured to form the cylindrical rearward portion 58 of the flange 56 (best shown in FIG. 5) with an axial length of about 3/16 inch. This portion of the flange is formed with a diameter which will fit within the counterbore 46 (shown in FIG. 1) worn into the tool holder 19 without requiring expensive machining. Since the counterbore 46 does not wear deeper than 3/16 inch, the overfill 60 will not interfere with the rotation of the tool 50, and does not have to be machined away.

Referring to FIGS. 4 and 13, the forward surfaces 45, 99 of existing tool holders 26, 101 have either a circular peripheral edge (forward surface 99 of tool holder 101 has a circular peripheral edge with a radius 105) or an arcuate portion of the peripheral edge (forward surface 45 of tool holder 26 has an arcuate portion at 107 with a radius 109). In accordance with another feature of the invention the cylindrical portion 58 of the radial flange 56 has a radius 103 that is larger than the radius 109 of accurate portion 107 or larger than that of radius 105 of circular forward surface 99. The tool body 50 can be easily removed from the associated tool holder 26, 101 using a hammer and a chisel to strike the portion of the radial flange 56 which extends beyond the radius 105, 109 of the tool holder 26, 101. The tool 50 having an enlarged diameter flange as described can be removed from a tool holder 26, 101 without using an extractor groove, thereby saving the cost of machining the extractor grove.

Referring to FIGS. 1 and 9, the hub 34 of prior art tools 10 are formed by fitting the distal end of the shank 22 in a die 93 having an inner surface complimentary to the desired shape of the hub 34, then "bumping" the distal end with a punch 95 to expand the distal end of the shank 22 into the contour of die 93.

Referring to FIG. 10, to form the hub 70 of the present invention, a die formed of a plurality of segments, two of which 96, 97 are visible, has a forward central opening 98 sized to slideably receive the distal end of the partially formed cylindrical shank 64. Behind the central opening 98 is a first enlarged diameter cavity 100 for forming the forward cylindrical hub portion 71, and behind the first enlarged diameter portion 100 is a second, somewhat smaller diameter cavity 101 for forming the rearward hub portion 73, with a shoulder 103 between cavities 100 and 101. A generally cylindrical punch 102, the outer diameter of which is not larger than the inner diameter of the rearward central portion 100 of the die 96, 97 has an axially positioned conical protrusion 104 therein.

Referring to FIG. 11, after the punch 102 has been struck against the distal end of the cylindrical shank 64, the impact of the punch 102 forces the conical protrusion 104 into the distal end of the shank 64 and causes the metal of the shank to be expanded into the two cylindrical cavities 100, 101 of the die 96, 97 as shown. Thereafter, the segments 96, 97 of the first die can be removed from around the shank 64 to leave a hub 70 having an extended length with a large diameter forward cylindrical portion 71 and a rearward, smaller diameter cylindrical portion 73, the portions 71, 73 separated by a shoulder 75.

Referring to FIGS. 4 and 4A, when the tool 50 is inserted into a tool holder 26, the tool 50 will be retained within the bore 24 of the tool holder 26 by a sleeve 112 made of a spring steel similar to the sleeve 38 of the prior art, but having a somewhat shorter axially length. To compensate for the shorter length, the steel from which the sleeve 112 is made, is ten percent to fifteen percent thicker than the sleeve 38 of the prior art. A shoulder 117 between the hub 70 and the cylindrical shank 64 will engage the rearward edge of the sleeve 112 and thereby retain the tool 50 within the tool holder 26 as was the case in the prior art. The forward end of the sleeve 112 cannot, however, become wedged between the frustoconical portion 66 of the tool 50 and the complimentary frustoconical portion 116 of the holder 26, but will instead contact the shoulder 68 (best seen in FIGS. 4A and 5) and therefore will not inhibit rotation of the tool 50 within the block 26 as can occur with the tool 10 in the prior art.

As explained above, the hub 70 of the tool 50 has a longer overall length 72 than the hub 34 (shown in FIG. 1A) of the prior art tool 10 and preferably has a length of ½ inch. The forward cylindrical portion 71 has an axial length of about ¼ inch and the rearward portion 73, which may be frustoconical, but is preferably cylindrical as shown, with the rearward cylindrical portion has an axial length which is substantially equal to that of portion 71, or ¼ inch. The benefit of this configuration is that the smaller diameter rearward portion 73 of the hub 70 facilitates the insertion of the shank 64 of the tool 50 into the bore 24 of the tool holder 26 and facilitates the aligning of the tool 50 with respect to the bore 24 of the tool holder 26 and thereby reduces the time required for replacement of a tool. Another advantage of the smaller diameter cylindrical rearward portion 73 of the hub 70 is that it can be used to assist in axially aligning the retainer sleeve 112 with the shank 64. As the sleeve 112 is thereafter forced onto the shank, the shoulder 75 between the portions 71, 73 of the hub will open the sleeve 112 and thereby assist in the assembly of the sleeve 112 over the shank 64.

Referring briefly to FIGS. 1 and 1A to compare the hubs of the invention with hubs 34 of the prior art with a shorter length, such prior art tools 10 have been found to become easily misaligned with respect to the bore 24 during the insertion thereof into a tool holder. When the forward cutting end 12 of the tool 10 is thereafter struck with a hammer to insert the tool, the misaligned tool causes damage to the inner surface of the bore 24. Such damage is prevented in the case of the present invention because the smaller diameter rearward portion 73 thereof assists in aligning the axis of the tool 50 to an orientation very near to the orientation of the bore 24. In addition to facilitating the alignment of the tool 50 in the bore of the tool holder 26, the longer hub 70 provides a greater surface area of the hub 70 to engage the inner surface of the bore 24 and thereby reduced the friction between the surfaces and reducing the rate at which the inner surface of the bore 24 becomes worn.

Referring to FIG. 16, another benefit of the longer hub 70 is obtained when tools according to the present invention are inserted into the bore 128 of a tool holder 130 in which prior art tools had been employed. After extended use, the hubs of such prior art tools will wear an enlarged diameter portion 132 at the rear of the bore 128, such that if another prior art tool is inserted into the holder 130 the tool will wobble in the holder. On the other hand, if a tool **50** in accordance with the present invention is inserted into the bore **128** the forward cylindrical portion **71** thereof will engage a previously unworn portion **134** of the bore **128**. Tools **50** in accordance with the present invention are therefore useable as replacement tools in tool holders **128** which have become worn from prior art tools, thereby greatly extend the useful life of the tool holder.

Referring to FIGS. **4**, **12** and **13** in accordance with another feature of the present invention the sleeve **112** has a length **114** which is about 3/16 inch shorter than the distance **115** between the shoulder **117** formed by the hub **70** and the shoulder **68** adjacent to the frustoconical section **66**. The presence of the shoulder **68** allows the close tolerances as set forth above, and those tolerances prevent most of the fine particles loosened by the tool **50** in the cutting process from working between the inner surface of the sleeve **112** and the shank **64**. It has similarly been found that sizing the width of the sleeve **112** so that the ends **116**, **118** thereof are spaced a distance **120** of no more than 0.030 inch apart when the sleeve **112** is fitted into the bore **122** of the tool holder **101** will further prevent particles of hard material loosened by the cutting tip from working between the shank and the sleeve.

Prior art tool **10** has a hub **34** with a diameter which is a little less than the diameter of the bore **24** of the tool holder **19** in which it is fitted. The diameter of the shank **22** on the other hand, is significantly smaller than that of the bore **24**. The hub **34** of such prior art tools, therefore, facilitates the retention of the sleeve **38** on the shank **22** and acts as a bearing to facilitate rotation of the tool **10**. One standard size diameter for the bore of a tool holder is 0.7825±0.0025 inch, and the standard diameter of the hub **34** for tool **10** is 0.765±0.005 inch, allowing 0.009 inch spacing per side between the outer surface of the hub **34** and the inner surface of the bore **24**.

Referring to FIG. **14**, in the preferred embodiment the shank **64** of the tool **50** has a diameter **124** sized for closer tolerances between the corresponding parts of the prior art. A tool **50** sized to fit within a 0.765 bore **125** will have a shank **64** diameter of 0.672±0.005 inch. As previously stated, the sleeve **112** is made of a thicker gauge of steel to compensate for its shorter length, and for tools sized to fit in a 0.783 inch diameter bore, the sleeve **112** has a thickness **126** of 0.045 inch. As a result the spacing **128** between the outer surface of the shank **64** and the inner surface of the sleeve **112** is 0.010 inch. The spacing between the shank **64** and the sleeve **112** is approximately the same as the spacing between the outer surface of the hub **70** and the inner surface of the bore **122**. Unlike prior art tools **10**, **10'**, the shank **64** of the tool **50** therefore also acts as a bearing surface to facilitate rotation of the tool **50** within the bore **112** of the tool holder **26**, **101**.

For the purposes of this discussion it should be appreciated that the term "tool holder" applies to any form of a cutting tool holder and is not limited to a block as depicted in many of the drawings. Specifically, the term "tool holder" includes a cutting tool holder which may be a single block or a replaceable tool holding structure which is retrained in a block on a machine.

While the present invention has been described with respect to a single embodiment, it will be appreciated that many modifications and variations can be made without departing from the true spirit and scope of the invention. It is, therefore, the intent of the following claims to cover all such variations and modifications which come within the true spirit and scope of the invention.

What is claimed is:

1. A cutting tool comprising

a cylindrical shank having a distal end,

a cylindrical hub at said distal end of said cylindrical shank,

a radial flange forward of said cylindrical shank,

a cutting end forward of said radial flange,

said cutting tool having a longitudinal axis,

said radial flange having an annular rearward surface,

said annular rearward surface defining a plane perpendicular to said longitudinal axis of said cutting tool,

a frustoconical portion between said annular rearward surface and said cylindrical shank, and

an annular radial shoulder between said frustoconical portion and said cylindrical shank.

2. A cutting tool in accordance with claim **1**, and further comprising a spring loaded retaining sleeve around said cylindrical shank.

3. A cutting tool in accordance with claim **2** and further comprising,

said shank having a distal end,

a hub on said distal end of said shank,

a second annular radial shoulder between said hub and said shank, and

said spring loaded retaining sleeve having a length which is no more than 1/16 inch less than the distance between said annular shoulder and said second annular shoulder.

4. A cutting tool in accordance with claim **3** where said cylindrical hub has a length sufficient to align said tool in a bore of a tool holder.

5. A cutting tool in accordance with claim **1** wherein said cylindrical hub has a length sufficient to align said tool in a bore of a tool holder.

6. A cutting tool in accordance with claim **1** wherein said flange further comprises

a cylindrical portion having a first diameter and

an overfill portion forward of said cylindrical portion, said overfill portion having a diameter greater than said first diameter.

7. A cold formed tool body comprising

a tapered forward end,

a radial flange axially aligned behind said tapered forward end,

a cylindrical shank axially aligned behind said radial flange,

said radial flange having a cold formed cylindrical portion,

an annular bulge of overfill forward of said cylindrical portion,

a frustoconical portion behind said radial flange and forward of said cylindrical shank, and

a shoulder between said frustoconical portion and said cylindrical shank.

8. The combination comprising

a tool holder having a body with a forward surface,

said forward surface having a portion with an outer edge,

an aperture in said body opening in said forward surface, said aperture having a longitudinal axis,

a tool body having a tapered forward end, a radial flange axially behind said tapered forward end, and a cylindrical shank axially behind said radial flange,

said cylindrical shank extending into said aperture, said radial flange having a rear surface forward of said forward surface, said tool body having a frustoconical portion between said radial flange and cylindrical shank and a first radial shoulder between said frustoconical portion and said cylindrical shank,

said cylindrical shank having a distal end, a hub at said distal end and second radial shoulder between said hub and said shank,

a spring loaded retaining sleeve on said shank between said first radial shoulder and said second radial shoulder, and

said spring loader retainer having a length no more than 1/16 inch less than the distance between said first radial shoulder and said second radial shoulder.

9. The combination of claim **8** wherein

said spring loaded retainer has two elongate parallel ends spaced from each other, said ends extending axially along said shank, and

said ends are spaced from each other a distance of not more than 0.030 inch.

10. The combination of claim **8** wherein

said spring loaded sleeve has a first inner diameter when said spring loaded sleeve is inserted in said aperture,

said shank has a second diameter between said first radial shoulder and said second radial shoulder,

said aperture has a third diameter,

said hub has a fourth diameter, and

the spacing between said first diameter and said second diameter is near the spacing between said third diameter and said fourth diameter wherein both said hub in said bore and said shank in said sleeve act as bearings for rotation of said tool in said aperture.

11. The combination of claim **10** wherein said spacing between said first and second diameters has a mean difference from said spacing between said third and fourth diameters of no more than 0.002 inch.

12. The combination comprising

a tool holder and a rotatable cutting tool wherein

said tool holder has a holder body with a cylindrical bore therein, said cylindrical bore having a standard length and a given diameter,

a rearward portion of said cylindrical bore having been enlarged by wear so as to be larger than said given diameter,

said cutting tool has

a tapered forward end having a central longitudinal axis,

a hard cutting tip on said forward end,

a radial flange axially aligned behind said tapered forward end,

a cylindrical shank having a central portion, distal end and a length at least equal to said standard minimal length,

a compressible sleeve fitted around said central portion,

an enlarged diameter hub at said distal end of said shank,

said enlarged diameter hub having a forward portion and a rearward portion,

said forward portion being cylindrical and having a diameter a little less than that of said given diameter wherein said forward portion serves as a bearing to facilitate rotation of said tool while said shank of said tool is retained in said bore of said tool holder by said compressible sleeve, and

said forward portion of said enlarged diameter hub is positioned within said bore forward of said rearward portion of said cylindrical base.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,742,735 B2
DATED : June 1, 2004
INVENTOR(S) : Phillip A. Sollami

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

<u>Column 1,</u>
Line 14, after “of” first occurrence, delete “cuffing” and substitute -- cutting --.

<u>Column 6,</u>
Line 61, after “flange 16” insert -- of --.

<u>Column 8,</u>
Line 42, after “inventions,” insert -- in --.

<u>Column 13,</u>
Line 3, after “and” insert -- said --.

<u>Column 14,</u>
Line 17, after “portion,” insert -- a --.

Signed and Sealed this

Fourteenth Day of December, 2004

JON W. DUDAS
Director of the United States Patent and Trademark Office